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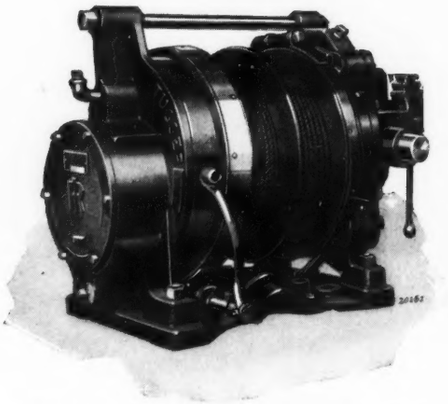

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Electricity Displaces Steam in Mechanical Shoveling

ELECTRIFICATION of power shovels has been the outstanding feature of the general trend toward electrifying the mining industries in the last few years. As between the electrically operated and the steam-driven shovel, the tendency toward the former has been more marked in the larger sizes. Adoption of the smaller electric shovel, however, has been increasing rapidly. The steam machine, on the other hand, is passing out of the picture. It is understood that one important manufacturer will not carry it in stock, but is producing the smaller sizes of electric shovels as rapidly as possible.

Evolution of the electric shovel to its present status has taken place within the last decade. A little more than seven years ago the company responsible for furnishing the electric equipment for the majority of electric shovels in use today first undertook this work. Since then it has equipped more than 600 electrical machines. Considering the risk involved in the effort to produce a shovel that would be of greater capacity, more efficient, and more easily handled than any of its predecessors, the nerve displayed arouses admiration. Indeed, it took considerable courage to develop the electric shovel to its present status. Failure after failure, it is said, was recorded. In applying electricity to this machine the development at the outset was based largely on guesswork. No one knew what strains would be encountered. With nothing between the driving motor and the power source, it was evident that, if anything stuck, the motor would burn out or something would break. The start was made, moreover, with a single motor, the power being transmitted to the various motions with a clutch. Today, up-to-date design calls for a separate motor for every motion. The loads handled by the larger shovels are so heavy that it is hard to find a transmission clutch able to stand the service.

With these facts in mind, some will look upon the electric shovel with renewed interest. Each announcement of an improved and larger model will carry with it a new significance. Despite such mental preparation, however, one is nevertheless certain to be amazed at the capacity and dimensions of the newest excavator of this type, now being built for coal stripping in Illinois. This shovel is truly a dinosaur among machines of this type. It will take 15 cubic yards at a single bite. A few years ago one marveled at the huge size of the 8-yard dipper, which seems small now in comparison with the dipper of the new monster. The shovel, moreover, has a boom 120 feet long and weighs 1,350 tons—thrice as much as the 8-cubic-yard machine. It will work to a radius of 150 feet and will load to a height of 100 feet. These are impressive dimensions.

And why the trend to the electric shovel? Because it costs less, much less, to operate and maintain. One company has found that the maintenance expense of its electric shovel is but one-fifth that of the steam machine of the same capacity formerly used. This evidence provides ample reason for the change.

Before passing on to other matters, one might pause to consider what would have been the position of the mining industries today were it not for the enterprise, ingenuity, and creative ability of those who design and perfect such machines, each of which takes the place of a veritable army of men equipped with hand tools. The manufacturer has been and is an important factor in and an integral part of the mining industries. The mining engineer is dependent to a considerable extent on his initiative and perseverance in the perfection of equipment without which the technical improvements and operating economies that have played so important a part in the recent history of the world could not have been effected.

Annual Company Reports and Increased Federal Appropriations

VARIOUS AGENCIES have, directly and indirectly, made strenuous appeals to the national legislative bodies for increased appropriations in the interests of the mining industry, particularly in behalf of the Western metal-mining states. Collectively, much effort has been expended to remedy a condition long recognized as deserving of attention, but little or no real success has been achieved. More statistics and a greater popular demand for the desired federal action are required by the national legislators, although it would seem that ample data have been presented and that sufficient demand prevails to make such action advisable without further delay.

In final analysis, the problem appears to be one of selling a majority of the national legislators on the wisdom of the course of action desired. And it is in this direction that the individual mining company can render much greater assistance than it has rendered heretofore. Selling today presupposes a certain amount of advertising. In this instance the most valuable type of advertising, of course, would be that creating the widest demand from the greatest number of citizens for increased federal appropriations. That is the goal. Such a demand, however, cannot be brought about overnight, but popular interest in the subject would undoubtedly be increased if the mining companies, in their annual reports, which reach thousands and perhaps millions of stockholders, usually considered outside the industry, would incorporate statistics and data that are fundamental advertising. By this is meant the presentation of such information as the revenue accruing to

railroads as a result of the company's operations; the percentage of the total county taxes paid by the company to the county in which it is operating; the total funds disbursed for wages and supplies; the number of workers dependent on the company's operations for a livelihood; the value and classification of products of other industries consumed by its employees—foodstuffs, household goods, clothing, and modern mechanical and electrical appliances, including automobiles. Following these statistics, comparison might well be drawn between the importance of the mining industry in the district with that of the other industries, and a brief statement made concerning the dependence of the latter on mining.

Information of this nature would not only give the stockholder a better understanding of the industry he is supporting, but it should also acquaint him with its importance and the legitimacy of its demands on the federal treasury. Such a course would also make available a mass of additional and necessary data now denied those at the helm of the industry, data that would aid them materially in pleading its cause.

The average annual report is usually a statement covering production, ore reserves, and financial condition, as brief as an expert accountant can produce. It is comparable at times with a bank statement in its appeal to the layman. Some curious stockholders may read it closely, but the majority undoubtedly do not. It is time the advertising possibilities of the annual report were recognized and utilized for the benefit of the industry.

The Cause and Prevention of Rock Bursts

THE conflicting opinions expressed in our news columns, in dispatches from Johannesburg, relative to the danger of rock bursts in the future development of the deeper mines of the Witwatersrand, prompt an appreciation of the suggestive article on the subject in a recent issue of our London contemporary, *The Mining Magazine,* by Mr. Bernard Beringer, whose conclusions are summarized as follows:

"(a) In certain rock masses the likelihood of rock bursts will be more acute than in others.

"(b) Deposits that dip at over 50 deg., in whatever ground, have to be mined more scientifically (from the safety point of view) than less inclined deposits.

"(c) That rock bursts in and about shafts are usually due to the shafts being wrongly located in relation to the reef, and also that shaft pillars where necessary are often too small and, where unnecessary, are always a danger.

"(d) Rock bursts during stoping operations are often due to the fact that the operations are too slow. A block of ground once started to be stoped should be stoped as rapidly as possible; also, stope faces of adjoining blocks when approaching each other (thus having between them what is to all intent and purpose a pillar) should be stoped even more rapidly than normally.

"(e) Failure to concentrate stoping operations is often the indirect cause of rock bursts."

It is evident that the hazard in question increases with the depth of the mine. Mr. Beringer's study of the subject should lead to an interesting discussion of a problem of growing importance in an industry that, as yet, has admitted no insuperable obstacle to the winning of metals from greater and still greater depths.

The Microscope and Metallurgical Losses

DATA of practical value in ore dressing may be obtained by the use of the microscope and the classification of information acquired thus. For instance, relatively little is known of the mineralogical form in which losses in tailing occur. Such losses usually are determined by chemical or fire analysis, which reveals little as to the mineralogical composition of the tailing and nothing concerning its physical characteristics. Such data not being available, it cannot be said with certainty that the highest practicable recovery has or has not been attained.

Few mill operators have sufficient mineralogical knowledge of the ore being treated to deny that failure to secure a higher recovery may be due to the existence of the metal in the form of rare or uncommon minerals causing losses by failure to plan for their recovery. Such minerals may be partly oxidized or tarnished, making it necessary to increase the amount of flotation reagents added. Or the presence of an unusual quantity of the products of rock decomposition may cause losses by changing the floatability of some of the associated minerals, either by acting as carriers of soluble salts or by coating the surfaces of the minerals to such an extent that they are not fully exposed to the flotation reagents used.

In the case of gold- and silver-bearing ores, the lack of knowledge concerning the mineralogical form in which the metal exists in the ore frequently is a primary cause of failure to accomplish recovery, or to control, with any certainty, concentration in one product, rather than a distribution through the several that are made. Failure to realize and correct such conditions means avoidable losses in many milling plants. A carefully conducted microscopic research usually provides information of great help to the operator.

Safeguarding Two Extremes

COMMERCIAL reflections of the safety movement are to be expected. It is natural that the enterprising should capitalize the concern for personal safety which the many appeals to caution have aroused in recent years. Manufacturers of mine equipment have long sought to safeguard human life, particularly in hoisting. Operators have been ingenious in making it difficult for their employees to hurt themselves. Campaigns to persuade men to be more careful have in fact become part of routine work.

Some of these devices and precautions will save a man despite himself. Others require his co-operation. In consequence, the success achieved with them cannot be readily discerned, except, perhaps, through accident statistics.

Among these devices are some of a peculiarly personal sort. The earliest and best known of them was the miners' safety lamp. It was designed to protect the life of the miner who carried it and that of all his fellows. Failure of an individual to use it brought upon him the censure of his associates.

Metal miners are more interested in guarding themselves against accident from falling objects. More accidents happen underground from this cause than from

any other. The Cornish hat and its "hard-boiled" contemporaries and descendants have given and continue to give valuable protection to those with sense enough to use them. A miner must wear a hat, if for no other purpose than to keep his head clean, and he exhibits intelligence when he selects one that will also prevent his skull from being cracked. At least one company—Moctezuma Copper, in Sonora—requires that everyone going underground must be provided with such a hat. If the cage must have a safety bonnet, why not the miner also? It is not too long past Easter to urge a new hat—of the safety sort—for every underground workman.

Footgear also is a timely topic. The miner has paid attention to keeping his feet dry and warm. He has sought shoes that are comfortable, oiled so that they won't leak, strongly soled for hard service, and studded with hobnails to keep his feet from slipping on the ladders. He has thought less of shoes with caps stout enough to prevent rolling and falling rock fragments or machine parts from crushing his toes. Perhaps he has never heard of them. Nevertheless such shoes are obtainable.

The wise workman will protect his feet as well as his head from injury, especially when it costs him nothing save the trouble of selecting the proper kind of foot and head gear. Use of safety hats will be limited to miners. Shoes with safety toe caps, however, will prove their value in any plant and in many other industries as well as in mining.

How Much Capital Goes Astray Thus?

CLOSE on the heels of the amazing discoveries of tin in Oregon comes a startling account of vast new deposits of platinum and gold in Idaho. The news filters through Reno, Nev., indicating that the marriage-dissolution business there is to be supplemented by the operation of an enterprise that aims to divorce the sucker from his savings. At a cost of only $200, one reads in the introductory circular letter, "you receive a bona fide deed to one full claim of approximately 20 acres in the Little Valley Mining District, Owyhee County, Idaho, together with 500 shares . . . in the Idaho Gold & Platinum Annex Mining Company. . . . All necessary assessment work has been done up to July 1, 1929," after which time you can hold your claim at an annual assessment expense of $12.50.

"During the past year and a half," writes the president and general manager, "I have financed exhaustive drilling and sampling of the New Bonanza District and with actual and personal assays, estimates and calculations at my finger tips, I am now ready to step into action in Little Valley and the work I am about to undertake will unquestionably make me independently rich and will likewise bring a tremendous return to every man who is with me, as the shaft of our company . . . wends [*sic*] its way to the original lava bedrock at a depth of around 200 ft.

"I have proven beyond a question of doubt that both Gold and Platinum exist in commercial quantities in our holdings. I have proven this indisputable fact through a systematic series of drill holes—drilled carefully through the four known strata to bedrock. In all I have financed the drilling of many holes. Each drill hole has shown startling values in both Gold and Platinum. In assembling my various assay sheets and striking a nominal average, we find through this extensive drilling program our values from the last drill hole ran as follows: First sand at 26 ft. ran $4.15 gold; second sand at 72 ft. $5.35 in gold and 0.48 oz. in platinum; third sand at 154 ft. ran $9.87 gold and 5.54 oz. in platinum and in the fourth underlying stratum and on what is known as the original bedrock, and the sand from which, of course, we will get the most amazing profitable results in this drill hole ran $108.98 in gold and one ounce in platinum."

One is not told whether these "values" are per ton or per acre, but we are assured, further, by the authority quoted, that:

"Sensational values in both gold and platinum have been ours in all our drill holes. If these values persist in our shaft to bedrock—and there is no reason to advance why they shouldn't—then my friend once our main shaft touches this bottom and reveals its content of gold and platinum, a mad boom rush will ensue overnight, causing such a parade of fortune seekers to the new bonanza as only camps like the Klondike, Goldfield, Cripple Creek, and other history makers can boast of."

In the minds of some, a degree of doubt may arise, with a difficulty of visualizing the work of boreholing and shaft sinking through sand. The sponsor at times is apprehensive, especially when he says that "assuming there are no platinum values at all, which supposition is ridiculous because of positive values of immense proportions having been proven through our numerous assays, the gold content alone is of such great value as to stagger the imagination of both the layman and expert."

For $200, as has been shown, one can acquire a right to about 20 acres, in addition to 500 shares. The promoter argues that "I think I am within reason when I predict that once our discovery shaft reaches your claim or claims would be immediately saleable at a price of from $5,000 to $15,000 each." To do this, the shaft must certainly "wend its way," as the prospectus intimates.

The promoter is an artist with an appreciation of the value of the "personal touch." "I am a miner pure and simple [*sic*]. This has been my life's game as far as I can remember and back of me for several generations is a typical mining genealogy [*sic*] which has seen genuine action in many of the history making camps now cited as producers of immense fortunes. . . . I have encountered a thousand and one heartaches; I have known all my life that I would eventually 'hit' in mining.

"I have not deviated from a set policy to eventually set myself for riches. I am convinced this goal is now within my grasp. I feel confident that within a relatively short space of time—now—my life's dream and ambition will have been fulfilled to an overflowing plenty. I can take you into this financial independence with me—if you will grasp this opportunity." And so on, *ad nauseam*.

How much capital is lured astray thus? It is an important question. On the outcome of mining venture rests the prestige of the mining industry. We commend the activities of the Idaho Gold & Platinum Annex Mining Company to the attention of the Post Office Department.

Combined Shrinkage and Caving Methods of Mining

By CHARLES A. MITKE
Consulting Mining Engineer, Phoenix, Arizona

A NUMBER OF MINES combine shrinkage and caving in the extraction of their ore.[1] Some of the deposits in which these methods are used are in the form of large bodies, which cover extensive areas, such as Ray, Morenci, Braden, and the iron mines of Pennsylvania; others are wide veins, or lodes, as Alaska Juneau, the Creighton mine, at Sudbury, and the Latouche Beatson mine, at Kennecott. The method is also applied to narrower veins—for example, Mount Hope, N. J.

In general, preparatory development work for the combined shrinkage and caving methods, up as far as the grizzly level, is somewhat similar to that required for the branch-raise caving. The ore is transported by gravity, through large incline raises, which connect the two levels and also provide storage. On the haulage level the ore is drawn directly into motor cars.

Under favorable conditions, where the ore shatters considerably after it is blasted in stopes, and little or no bulldozing, or secondary blasting, is required, it may be drawn directly into motor cars, without using a breaking level, or grizzly. This is the exception, however, rather than the rule. Though it is an advantage to have all the ore broken in the primary blasting, nevertheless, where this can be done, there is frequently the disadvantage that the ore is so soft that the haulage drifts become heavy and require much repair work. The old Ray motor haulage system dispensed with the grizzly level entirely, and so did the caving method used at the Coronado mine of the former Arizona Copper Company.

In most instances, the block to be mined is divided into rooms and pillars, the ore in the rooms, or stopes, being recovered by shrinkage, while that in the pillars is extracted by caving, simultaneously with the mining of the stope ore. Such is the method employed at the Creighton mine, in Sudbury, and in mining the harder ores of Morenci and Ray. In the larger deposits, it is frequently immaterial whether the stopes and pillars are carried parallel with the main strike of the orebody, or at right angles to it; through in the wide veins the stopes generally are laid out across the vein from foot to hanging wall; and in the narrower veins, such as at Mount Hope, they parallel it.

At Braden, a room-and-pillar method is also employed, but beneath the stopes is a system of incline raises for collecting the ore, locally known as the "ore-pass system," but which is very similar to the branch-raise system at Inspiration. The Creighton mine also uses an ore-pass system, located in the footwall of the vein. In the orebody at Alaska Juneau, an ore-pass system is also used to convey the ore from the grizzly to the main haulage level, 500 ft. below.

In the harder ores at Ray, 15-ft. stopes and 10-ft. pillars are planned, whereas at Braden the rooms are 23 ft., and the pillars 16.5 ft. wide; in the Creighton

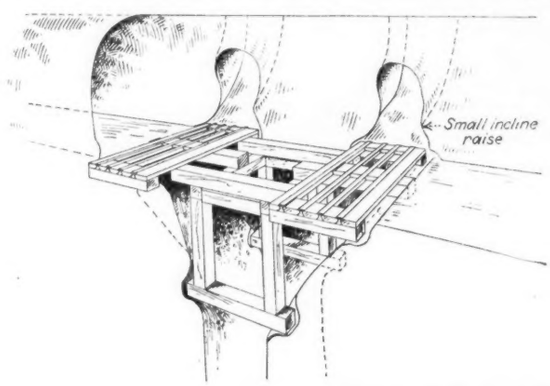


Fig. 1—Spacing of grizzlies on 14-in. laterals, with small incline raises branching therefrom, at Morenci

mine the stopes are 60 ft. wide and the pillars 15 ft., but in the lower levels this has been changed to a 50-ft. stope and a 25-ft. pillar. Morenci uses an 18-ft. stope and a 10-ft. pillar, and the custom at Latouche Beatson is a 70-ft. stope and a 30-ft. pillar, although in the lower levels this is being changed to a 60-ft. stope and a 40-ft. pillar. In the hard ore mined by shrinkage at Miami, in 1927, 50-ft. stopes and 50-ft. pillars were used. Alaska Juneau leaves numerous pillars to support the back during the preparatory work, but at the completion of this work they are blasted out, either by a large number of drill holes or by the use of small powder drifts. At Mount Hope, which is a vein deposit, the hanging and foot walls serve largely as supports.

Drifts on the grizzly level at each property parallel one another, and, at Ray, are driven on 25-ft. centers; and the grizzlies are located at 25-ft. intervals, along these grizzly drifts. At Morenci, on the other hand, the grizzly drifts are driven on 28-ft. centers, and the grizzlies, with small incline raises branching up on either side, are located at 14-ft. intervals, as shown in Fig. 1. Though the drifts on the grizzly level at Morenci are further apart than at Ray, the grizzlies themselves are closer. In the Creighton mine, the drifts on the grizzly level are 75 ft. apart in the upper, and 50 ft. apart in the lower, levels, and the grizzlies are located 15 ft. apart, at alternate points in opposite sides of the drift.[2]

[1] This is the ninth of the series by Mr. Mitke in which he outlines modern stoping methods.

[2] "Mining Operations, International Nickel Company," Canadian Mining Institute, 1920.

The grizzly drifts at Braden are approximately 25 ft. apart. At Alaska Juneau the grizzlies are spaced on 42-ft. centers, and at Latouche Beatson the grizzly drifts are driven on 100-ft. centers, with grizzlies spaced at intervals of from 60 to 75 ft.[3] In the former Miami shrinkage method, the drifts on the drawing-off, or grizzly, level were driven on 50-ft. centers, and the grizzlies spaced every 25 ft., whereas at Mount Hope the grizzlies are spaced approximately 40 ft. apart.

Interval Between Haulage and Grizzly Levels

At Morenci, the haulage level drifts are on 56-ft. centers, driven to accommodate ten-ton cars; ore raises, on 70-deg. inclines, are driven at 28-ft. intervals to the grizzly level, 45 ft. above. These raises are branched midway, so as to serve two grizzlies. The ore column above the undercutting, or grizzly, level was, at first, 140 ft., but is now being increased to 200 ft.

In developing a motor section at Ray, parallel laterals, spaced at 40-ft. intervals, are driven from a main fringe-drift. Usually, four such drifts are mined at a time, giving a width to the section of 160 ft., with an undercut along the drifts of 100 ft., and a vertical extent of anywhere from 100 to 200 ft., depending on the height of the ore. Both motor and hand tramming are used at Ray, the latter being employed to extract the outlying ore. The grizzly is approximately 50 ft. above the haulage level.

The haulage level at Latouche Beatson is 50 ft. below the grizzly, and the height of the ore between the grizzly and the mining level above is 150 ft., although under some conditions this may be as high as 250 ft. The main raises from the haulage level to the grizzly each serve two grizzlies.

At the Creighton mine 120-ft. lifts are taken, this being the interval between levels. Intermediate drifts, with box holes (grizzlies), are driven as required.

At Alaska Juneau, the grizzly level is 50 ft. above the haulage in the north end of the orebody, and the height of ore mined is approximately 200 ft., the stopes going through to surface, as the ore extends from the main haulage level to surface. In the south orebody, ore passes, with branches direct from the grizzly, are used to deliver the ore to the main level, 500 ft. below. Haulage-level drifts are driven on 80-ft. centers.[4]

The stopes are approximately 150 ft. high at Mount Hope, and the grizzly is about 50 ft. above the haulage. The same height of stope is also used at Braden. In the old Miami method, the grizzly level was 25 ft. above the tramming level, and the stopes were carried up 100 to 125 ft.

In the ordinary room-and-pillar shrinkage stopes, the grizzly drifts are usually driven at right angles to the stopes and pillars. The same is also true of the haulage drifts beneath. However, at Latouche and Mount Hope, the grizzly drifts are parallel with the shrinkage stopes. Practically all companies using combined shrinkage and caving start their undercutting level from inclines that have been driven up from each grizzly at an angle of about 40 deg. The inclines extend a distance of from 15 to 25 ft., and are belled out as they approach the proposed undercutting level. From these points, which are from 10 to 20 ft. vertically above the grizzlies, fan-shaped rounds are drilled on sufficient incline to allow the ore to run. This constitutes the first step in opening up the undercutting level.

In most operations, the grizzlies are in the center of the grizzly drift, and only two inclined raises are put up, one from each side of the drift. In exceptional instances, small crosscuts are driven out from the grizzly drifts and grizzlies are constructed at the ends of these crosscuts. In such instances, three incline raises are driven up from each grizzly. At Ray and Morenci, the grizzlies are in the centers of the drifts; at Creighton, they are on opposite sides of the drift, at alternate points. At Latouche Beatson, the grizzly drifts (or crosscuts, as they are called there) parallel the center line of the 70-ft. stopes, and are driven at 100-ft. intervals. On either side of this grizzly drift small offset drifts are driven, between 15 and 20 ft. long, and 60 to 75 ft. apart, and grizzlies are situated at the ends of these. The grizzlies are therefore 60 to 75 ft. apart, lengthwise of the stope, and 40 ft. crosswise. A similar line of grizzlies also is situated along the center line of the 30-ft. pillars. A somewhat similar plan of development is used at Mount Hope.

After the work on the grizzly level and the preliminary undercutting is completed, Latouche, Alaska Juneau, and Mount Hope all drive long incline raises, from the undercutting level to the mining level above, which is usually from 150 to 200 ft. distant. At Latouche these raises are 40 to 60 ft. apart, and at Alaska Juneau they are about 100 ft. apart and approximately 200 ft. high. When stoping begins, all ore is broken from these raises. At the Silver Dyke property, at Neihart, Mont., after the preliminary undercutting is completed, a series of churn-drill holes, spaced horizontally 20 and 25 ft. from the walls of the stopes, is drilled to within 15 ft. of the grizzly level.

The regular form of shrinkage stope with simultaneous pillar caving is in use at Ray, Morenci, Braden, and Creighton, and was used in the former Miami stopes, though, as previously mentioned, Latouche, Alaska Juneau, and Mount Hope employ a variation in which the preliminary development work is practically the same, the difference being in the manner of blasting the rock above the undercutting level. These variations will be described in detail later, as well as that used at the Silver Dyke.

Softer Ores Require Variations in Stoping Practice

In softer ores, the combination of shrinkage and caving assumes a somewhat different form from the ordinary method of shrinkage stopes and pillars. In such work it is merely necessary to isolate the block to be mined, by carrying up narrow shrinkage stopes, and then undercut the block (also by shrinkage), until it caves of its own weight. The height of this undercutting may be as little as 6 ft. or as much as 30 ft. Approximately 41,500 tons daily is produced by the combined shrinkage and caving methods.

In this method, alternate rooms and pillars are laid out. It is only necessary to cut off the block from the main mass by narrow "boundary shrinks" on the two ends, as stoping is laid out in such a manner that shrinkage stopes adjoin the solid on either side. After all the ore in stopes has been broken, the pillars are undercut.

At different properties the manner of carrying up the shrinkage stopes and undercutting the pillars varies, but after this work is completed, in every instance, the ore from pillars and stopes is drawn simultaneously. A

[3] "The Latouche System of Mining." Tech. Pub. No. 20, A.I.M.E., 1927.

[4] "Estimation of Ore Reserves and Mining Methods, Alaska Juneau," A.I.M.E., 1924.

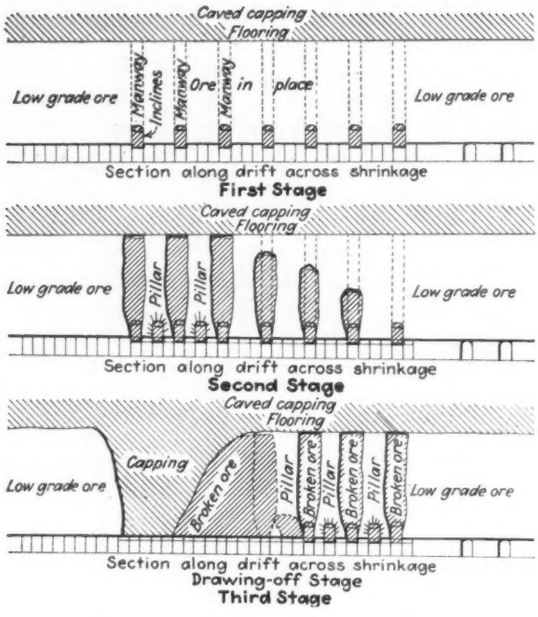


Fig. 2—Vertical section, across stope

grizzly level is usually driven, and bulldozing carried on there.

The men stand on the broken ore and drill the solid overhead, with either stopers or drifters. Sometimes the ore is broken by the miner drilling upward; in other operations it is broken off in big slabs by drilling horizontally; and in still others the ore is broken on the incline. Variations of these methods are used to undercut the pillars, the general plan being to put up raises and to undercut the pillars thoroughly before the final drawing begins.

Practice at Morenci

Figs. 2 and 3 show the three stages in the development of a shrinkage stope which was operated in the Humboldt mine, at Morenci, in 1920. Fig. 2 is a vertical section, across the shrinkage stopes, showing development from the time the drifts were driven, right through the process of carrying up both shrinkage stopes and pillars, to the final stage, where the ore is all drawn and capping appears in the chutes. Fig. 3 gives a vertical section along each shrinkage stope, also illustrating the various stages in the carrying up of each stope, from the incline raises, in the first stage, to the filled stope containing broken ore to the capping, in the final stage. The widths, of stopes and pillars were 12 and 8 ft. respectively. The original estimated tonnage was 100,000 tons; actual extraction was 110,624 tons; estimated average grade was 2.02 per cent copper, and average grade of extracted ore was 1.98 per cent copper. The actual feet of drifting per ton amounted to 0.024 ft., and the actual feet of raising per ton was 0.019 ft.

The tonnage extracted was over 10 per cent greater than the estimate, but the actual grade of the extracted ore was only slightly below the estimated grade; consequently, the additional 10,624 tons represented ore above the block mined, which was not included in the original estimate.

At Ray, "the shrinkage stopes in hard ore are carried to the capping, and at this point a final, or fan-shaped round, is put in to cut off the top of the pillar. Pillar raises are then connected across the block between the stopes, but in this case are carried up a short distance and widened out, and are really narrow stopes within the pillar. They are drilled and blasted when approximately 15 ft. above the pony cap, but the condition of the pillar as to its safeness is usually the controlling factor in the height to which it is carried. The block is then ready for drawing."[5]

In the hard ore mined at Miami some years ago "the shrinkage stopes were carried to a maximum height of 125 ft., it being necessary to break to the cap. In a typical stope of hard ore, the expansion in volume, due to breaking, required the drawing of 30 per cent of the ore in the stope, the latter being full at completion. . . . The process of breaking the pillars was practically the reverse of stoping. Mining was started at the edge of the ore, on the top sublevel, and carried downward, level by level; in each instance the 25-ft. roof-pillar was broken through to the broken ore above. . . . Systematic drawing of the broken ore was started when about 70 per cent of all stope and pillar mining had been completed. No draw was permitted within 100 ft. of any mining operations."[6]

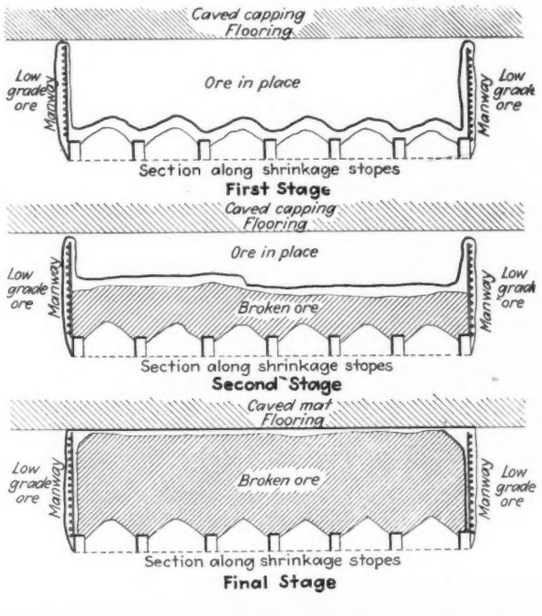
At Morenci, "boundary shrinkage stopes, 8 ft. wide, are mined to an elevation of about 10 ft. below the top of the ore, so as to cut off the panel to be caved. A transverse shrink, 18 ft. wide, is mined to a height of at least 70 ft. The adjacent 10-ft. pillar is undercut and caved as soon as the transverse shrink ahead of it is completed. The relative width of the room and its pillar, as well as the height to which the room should be carried, depend on the character of the ground."[7]

Floor and Boundary Shrinkage Stopes For Softer Ores

Where shrinkage stopes with simultaneous pillar caving are adapted to softer ores, it has been found that, provided the block to be mined has been isolated from the solid mass, it is not necessary to carry the shrinkage stopes the entire distance to the capping, as formerly, but

[5] "Mining Methods at Ray," R. Thomas, *Arizona Mining Journal*, April 15, 1926.
[6] *Mining and Scientific Press*, June 24, 1916, D. B. Scott.
[7] "Mining Methods at Morenci," *E. & M. J.-P.*, Dec. 26, 1925.

Fig. 3—Vertical section, along stope



merely a vertical distance of 25 to 50 ft., and that when drawing begins the balance of the ore crushes and caves of its own weight.

In some parts of the Captain orebody, at Miami (Miami Copper Company), this method was applied in the mining of the pillars. In describing it, T. A. Rickard states "about 20 per cent of the ore is stoped in order to induce the remainder to break away; in other words, five tons are mined by nature for every ton that is mined by man."[8] The method, as applied to the soft ores at Ray, is as follows:

"In preparing a block for drawing in soft ground, narrow side, or boundary shrinkage, stopes are carried up parallel to the laterals . . . so as to make a complete cut around the block that is to be drawn. These

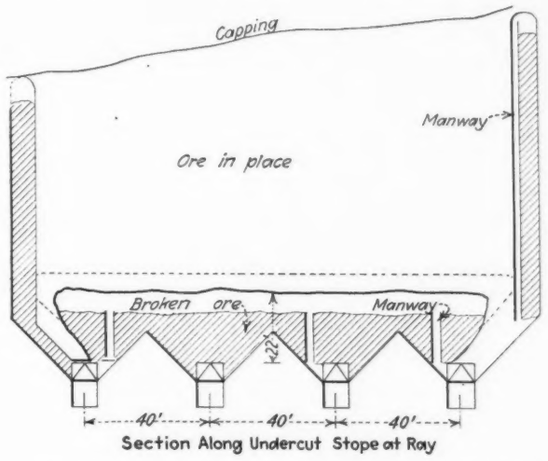


Fig. 4—Vertical view, along undercut stope (stope and pillar), soft ore (Ray)

are all regular shrinkage stopes and are provided with cribbed manways for the entrance of men and supplies. . . . After the side and end cut-off stopes have been completed, undercut (shrinkage) stopes are carried at 25-ft. centers within the solid portion of the block, and at right angles to the haulage drifts. . . . These stopes are carried to a height of 22 ft., when a final, or fan-shaped, round is put in. These undercut stopes are provided with cribbed manways, similar to the side and end stopes. . . . No open manways are provided for the undercut stopes. The undercut stopes are carried up approximately 10 ft. in width, and by the shooting of the final round are widened to approximately 20 ft. . . . After the undercut stopes are completed, pillar raises are connected across, at right angles to the drifts, and between the stopes. These raises are carried approximately 5 ft. wide by 6 ft. high, and when completed are leveled up and widened on top of the cone position, and are then drilled and blasted, thus making a complete undercut of the block. Fig. 4 shows a section through the block, illustrating the undercutting operation. After the block is undercut, drawing operations are started."[8]

In this operation, no grizzly level is driven, but the ore is drawn directly into motor cars, as with the old Ray motor haulage system. Not only is this method applicable to the softer ores, but it is also being successfully applied to the so-called "hard-rock" stopes in Morenci and Ray. This has been made possible by a more general use of boundary shrinkage stopes on three, and even four, sides of a block to be mined. However, where this method is applied to the harder ores, a grizzly level is necessary.

(To be continued)

[8] *Mining and Scientific Press*, Sept. 22, 1917.

Italy's Quicksilver Exports Decrease

ACCORDING to the U. S. Department of Commerce, the Societa Monte Amiata, the chief producer of mercury in Italy, has experienced a decline in its sales abroad. The dispatch attributes the drop in the volume of sales partly to a reported overproduction from the Spanish mines, accompanied by a relaxed demand on the London market, and adds that the influences are only temporary in character and that a reliable forecast as to their effects on the company's financial position is impossible at present. The operating year of the company closes March 31, and the stockholders' annual meeting will not take place until June, when the annual report will be presented.

For the first eleven months of 1927, the latest period for which figures are available, there has been a decided decrease in Italy's mercury exports, to 12,359 quintals from 16,311 quintals in the corresponding months of 1926. The declines in exports to Germany, Japan, and the United States, three of the chief countries of destination, are particularly notable, but exports to Great Britain seem to have held up fairly well. Exports for the eleven months' period of the last three years are shown in the following table (a quintal equals 220.5 lb.):

Destination	Jan.-Nov., 1925 Quintals	Jan.-Nov., 1926 Quintals	Jan.-Nov., 1927 Quintals
Austria	236	69	48
France	840	1,025	761
Germany	2,536	3,479	2,613
Great Britain	1,776	1,546	1,591
Japan	1,425	2,329	1,197
Hongkong	1,220	1,154	690
British India and Ceylon	842	924	507
United States	3,367	4,091	2,796
Other countries	1,158	1,694	2,156
	13,400	16,311	12,359

Analysis of Chrome Iron Ore

FUSION of chrome iron ore with sodium carbonate is never complete, according to E. Dittler in *Z. angew. Chem.*, 1928, 41 pp. 132-133 (abstracted in *Chem. & Ind.*), and the analysis is best carried out in the following manner: The finely ground mineral is fused with ten times its weight of sodium peroxide in a silver crucible, the melt dissolved in water, acidified with hydrochloric acid, and the precipitated silver and silver chloride removed. The filtrate, to which a few cubic centimeters of hydrogen peroxide have been added to reduce the chromium present, is evaporated to dryness and the silicic acid removed by evaporation with hydrofluoric acid; the residue is decomposed with sodium carbonate and a little potassium nitrate, and, after treatment with hydrogen peroxide, the combined oxides of aluminum, iron, and chromium are precipitated with ammonia solution. Provided that excess of hydrogen peroxide is removed before precipitation, all the chromium is obtained as oxide. The three oxides are treated with sodium peroxide, when the iron remains as insoluble residue and the chromate is determined volumetrically in the filtrate after conversion of the manganese present into manganese dioxide while the aluminum content is obtained by difference. In the filtrate from the three oxides, calcium, magnesium, and manganese are determined by the ordinary methods.

LIME and Its Manufacture

A Review of the Methods Commonly Employed

LIME is a commodity so widely used—in the mining industry as in others—that often an advantage may be gained in manufacturing it locally, provided a supply of crude rock is readily available. It may be required not only in the metallurgical plant, as in flotation and cyanidation, but also for building and agricultural purposes. If the camp be remote and freight charges high, it behooves the person responsible for operations to study the art of burning limestone. Methods are simple, when understood, and so is the essential equipment.

DESPITE the common use of lime, exact information regarding many of its properties in the slaked and unslaked conditions is meager. To ascertain the factors affecting the quality of lime during burning and that of the hydrated product during commercial slaking processes, with full appreciation of the practical difficulties, a study of the method of lime manufacture was undertaken by the U. S. Bureau of Standards. The results of this study are set forth in a circular[1] recently issued by the Bureau.

In this paper the equipments of various plants and processes are compared, with special reference to economy of operation and quality of finished product. Results of some laboratory work are included. The comparative heat efficiency attained by the use of different methods of creating the draft was investigated.

Burning of lime may be defined as the process of converting limestone into lime through the agency of heat. The term "limestone" is used to describe a class of rocks varying in composition from pure calcium carbonate to a mixture of 54.35 per cent calcium carbonate with 45.65 per cent magnesium carbonate. Any gradation between these limits may be found, and all limestones contain more or less impurities. Thus, the resulting lime may vary from pure calcium oxide to a mixture of calcium and magnesium oxides in the corresponding proportions. The accompanying impurities may or may not be removed.

Chemically and physically, the quality of limestone suitable for burning may vary within rather wide limits. Only those limestones may be used from which a marketable lime can be produced. It must be remembered that on account of the loss of about half the weight of the stone as carbon dioxide during the burning, the proportion of every other constituent of the stone will be nearly doubled in the lime. The amount of impurities (silica and oxides of lime and aluminum) permissible in a finishing lime (quicklime or hydrate) is very small, certainly not over 5 per cent (2½ per cent in the stone). In chemical industries the value of lime depends largely on the amount of the active constituent. Therefore the impurities act usually as diluents, and for many purposes their presence in rather large amounts is not harmful, except where a finishing lime or a particular grade of chemical lime is to be made. The following general conclusions may be drawn: The presence of small amounts of silica tends to decrease the plasticity, sand-carrying capacity, and yield of a lime, but has no apparent effect on its hardness or strength. This may also be said of iron, except that lime containing large amounts (25 per cent) shows a marked increase in both strength and hardness. Alumina increases all of the factors above mentioned and also improves the color, so that its presence, even in large amounts, is desirable. Gypsum shows detrimental effects, even when only 1 per cent is present. Kaolin seems to act in a manner similar to silica and iron.

Chemical composition influences the cost of burning. Generally, less heat and a lower temperature are required to burn a magnesium than a high-calcium stone. The greater the proportion of impurities, the more easily is the lime overburned, and therefore too large an amount of these impurities will reduce the capacity of the kiln. Too high a proportion of silica may cause "fire slaking," whereby the lime falls to pieces.

Any kind of limestone is suitable for burning, so far as its physical properties are concerned. These, however, influence the cost of production noticeably. Fine-grained, dense stone can be burned at a lower temperature and with less heat than one which is coarsely crystalline and porous. Coarse stone, especially if pure, is likely to fall to pieces in the kiln, reducing the production of lump. Water contained in limestone must be evaporated. Some of it may not be given off until the stone has reached a red heat.

[1]Circular No. 337, "Manufacture of Lime." U. S. Bureau of Standards. Price 45c.

In burning lime three factors are essential: (1) The stone must be heated to the temperature of dissociation of the carbonates; (2) this temperature must be maintained for a certain length of time: (3) the carbon dioxide evolved must be removed. The dissociation temperature for calcium carbonate is 898 deg. C. That for magnesium carbonate may be taken as 750 deg. C.

To summarize, a certain quantity of heat must be supplied to dissociate the carbonates. This quantity will vary with the chemical and physical properties. It is optional to use either a high temperature for a short time or a lower one for a longer time. A slight increase of temperature will increase the dissociation pressure decidedly and thereby reduce the time required to produce a given quantity of lime. If magnesium carbonate is present in appreciable quantities a lower temperature should be used. The more nearly the amount of heat used approaches the minimum required, the better will be the quality of the lime.

The chemical action involved in burning lime is reversible; and the factor which determines the way the reaction shall go is the pressure of carbon dioxide. To prevent recarbonating it is essential that the gas produced be removed rapidly and continuously.

Composition of Commercial Lime

Commercial lime may contain anywhere from 0 to 44 per cent magnesium oxide and generally more or less impurities, such as silica and oxides of iron and aluminum. When properly burned and fresh from the kiln it should contain no water and less than one-half of 1 per cent of carbon dioxide. The lime will usually have the same form as the stone, but will be much more porous. Impurities present may give it a gray, pink, or yellow tinge.

When lime is slaked the calcium oxide combines with water to form calcium hydroxide. Recent work indicates that 40 to 70 per cent of the magnesium oxide, if any is present, will hydrate in the commercial process.

Heat is generated by the hydration of calcium oxide. Since a part of the magnesium oxide does not hydrate, this acts merely as an inert substance. Other things being equal, the less magnesium oxide present the more quickly the lime will slake and the greater will be the amount of heat generated.

The more porous the lime the more quickly will the chemical combination take place. A very porous dolomitic lime may slake more quickly than a dense lime having a higher content of calcium oxide.

If lime is underburned, the calcium carbonate left in it acts as inert matter. Overburned lime will exhibit the same phenomenon. The appearance of underburned lime varies with that of the stone and can be distinguished only by one who has had practice with the particular lime in question. Overburned lime is generally yellow or black in color and can be readily separated from good lime.

When lime is exposed to the air it absorbs carbon dioxide and water and "air-slakes." This reaction consists in, first, the absorption of water and, second, the displacement of the water by carbon dioxide. Since these reactions are slow, it is possible to obtain lime which has air-slaked at almost any degree. For this reason at one stage of the process the product may be similar in composition to "water-slaked" or hydrated lime. To avoid this confusion, the Bureau of Standards has decided to designate as "air-slaked lime" only that product in which the process has been completed. Any intermediate product will be designated as partially air-slaked.

Absorption of water during the process of air-slaking involves a large increase in volume, and therefore the lumps fall to pieces. This fact was an obstacle in the introduction of hydrated lime because the consumer believed that all fine lime was air-slaked.

There are several grades of limestone which fall to pieces in the kiln. The stone may be so soft that it is broken up by abrasion; it may have its pores filled with water, which when heated shatters the stone; or its component crystals may be bound together by organic matter which is consumed in the kiln. Stones like these are being burned, and in some operations over 50 per cent of the output of the kiln is fine stuff. Such fine lime is as good for all purposes as lump lime and it is easier to handle and will keep better.

The weight of a lump of lime is about 55 per cent of the weight of the stone from which it was burned. The federal lime-barrel law makes a large or small barrel of lime 280 or 180 lb. net., respectively.

Hydrated Lime—Its Advantages

Hydrated lime is a product of comparatively recent origin. It is lime which has already been hydrated; that is, the chemical combination with water has already taken place. It is a fine, dry, white powder, which is shipped in paper bags and which may be used for a number of purposes instead of lump lime.

Mining, Sorting, and Loading

After being broken in mine or quarry, limestone must be sorted, in order that only the proper quality and size of stone may be put into the kiln. Where rotary kilns are used, this latter phase is taken care of by crushers.

With vertical kilns the size of stone to be used depends on two considerations: A hard dense stone may be used in smaller sizes than one which is soft and has a tendency to fall to pieces in the kiln. If the draft is normally rather low, large stone should be used, or the draft may be choked below its economical limit. It is the custom to use anything from a stone as large as one man can readily handle down to one about 4 in. in diameter.

When limestone is mined underground, clay and other contaminating substances usually encountered in quarry working are eliminated. This is a matter of concern to some users of limestone, for the purity of the stone is of advantage. In wet weather, clay sticks tenaciously to the stone obtained in open quarry work. The clay is siliceous, and as a result the lime may be of poor quality.

Lime burning is a continuous process. It is most economical to run the kiln at full capacity. Thus a steady supply is necessary.

Where rotary kilns are employed it is never practicable to dump directly from the cars or carts into them. The stone must be comparatively uniform in size, from ½ to 1½ in. for the most economical operation. This necessitates reduction and grading of the rock as it comes from the mine. Storage bins are necessary.

Of the kilns used in the United States for burning lime, the shaft kiln is most generally employed. In recent years, however, the rotary kiln has come into extensive use. Use of the rotary kiln is limited to the manufacture of hydrated lime and a more recent form of quicklime termed "pebble lime." This latter product is quicklime averaging about one inch in diameter.

In general, a shaft kiln resembles a short, wide stack, either square, round, or elliptical in cross-section. It consists of a casing of steel or stone lined with refractory material. The long, vertical chamber formed by this

lining may be divided into three compartments: The top one, called the hopper, is used for storing and preheating the stone. Its sides slope in so that the stone may slide down into the middle compartment, the shaft. This shaft is where the lime is burned. It may be square, round, or elliptical in cross-section independently of the outside of the kiln. Generally, the sides of the shaft are vertical, although in some cases they slope outward. In this latter method of construction it is customary to omit the hopper.

Below the shaft is the cooler, which is used for storing the lime after it is burned. The top of the cooler, of course, has the same cross-section as the shaft. The sides are drawn in to form a slide leading to the drawing door. A hole in the side or bottom of the cooler is closed by a door or by sheets of iron which swing on a pivot and are known as shears. The lime is removed through this opening. The fuel used in burning is consumed in the fire boxes usually arranged on two sides of the kiln. These are very similar to the common fire boxes in use under boilers. To increase the natural draft a stack is sometimes placed on top of the kiln. Forced or induced draft, or a combination of both, is also in common use.

The cross-section of the shaft is limited by the distance the heat can be made to penetrate toward the center. The total height of the kilns above the grates is limited by the conditions of the draft. If natural draft is used, the gases must leave the top of the kilns hot enough to produce the draft; that is to say, the kiln must not be too high. With any form of induced draft the kiln should be just high enough so that the gases reaching the top have approximately the same temperature as the external air.

Although there are numerous designs of lime kilns, they may be divided, for classification, into the types shown in Figs. 1, 2, 3, 4, and 5. The diagrams in these figures are intended to be merely composite designs, showing the more important points of variation.

The rotary kilns which are used in burning lime are similar to those which have been successfully used for years in making cement. This kiln is essentially a steel cylinder 6 to 9 ft. in diameter and 60 to 200 ft. long, which is supported on trunnions and rotated. It is set in a slightly inclined position, the inclination being usually about one-half inch to the foot. The rotating section is lined with some type of non-abrasive fire-resistive material. The crushed lime-rock is fed into the upper end of the kiln, while the fuel, which may be powdered coal, oil, or gas, is forced in at the lower end. A draft is maintained usually by means of a fan. As the stone passes through the kiln, it is burned and, at the lower end, drops into a cooler, which is a rotating steel cylinder, but much shorter than the kiln. Cooling of the lime is effected by exposing it freely to the air in the second cylinder.

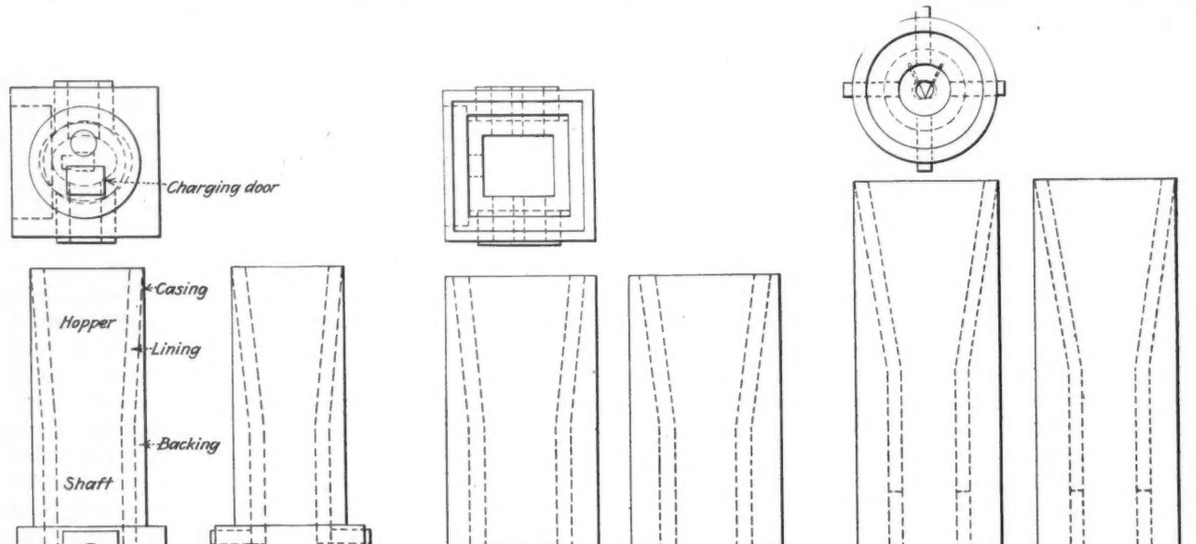


Fig. 1—Round kiln with shaft drawn in. Fig. 2.—Square kiln with straight shaft. Fig. 3.—Round kiln with straight shaft.

Size of Kilns

The practical size of a kiln is limited by many considerations, chief of which is probably the market which the kiln has to supply. Lime is a perishable article, so that any cessation in demand necessitates curtailment of supply. If the market demands a definite supply of lime for a continuous period, a kiln can be built large enough to supply that demand. Generally, however, it is safer to build a number of small kilns, so that if the demand falls off it is not necessary to close down the entire plant. A custom which is becoming prevalent is to run the kilns at full capacity and hydrate that portion of the lime which cannot be used immediately, for hydrated lime may be stored.

The casing, or outside shell of a kiln, in conjunction with the backing must carry part of the weight of the kiln; it must protect the lining from excessive changes in temperature and must minimize the amount of heat lost by conduction and radiation. Casings may be divided into five classes:

1. Square stone casings. These are usually built one

stone, or 9½ in., thick at the top, extending straight down on the outside, and following the contour of the hopper shaft and cooler on the inside. They are illustrated in Figs. 1 and 2.

2. Round steel casings as shown in Fig. 3. These are made of sections of steel plate, rolled to shape and bolted together.

3. Conical steel casings, a variation of the round type.

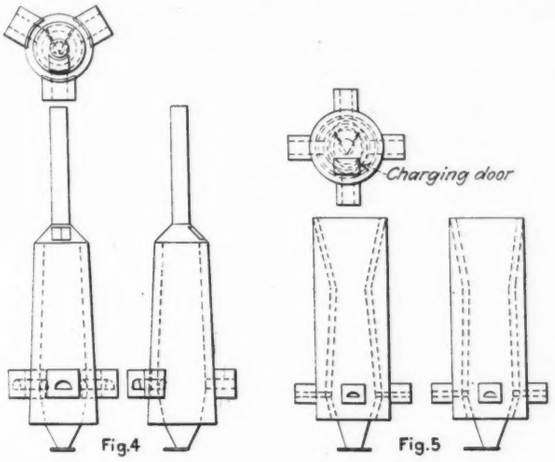


Fig. 4—Round kiln with flaring shaft. Fig. 5.—Round kiln with distorted conical shaft.

4. A combination of steel with stone or other material. In this case a cubical structure large enough to inclose the fire boxes is built of stone, brick, or concrete and the steel casing is built upon it.

5. A variation of the preceding class in which the fire boxes are above and independent of the stone, brick, or concrete structure, as illustrated by Fig. 4.

For carrying the weight of the kiln, steel is probably more satisfactory than stone.

Loss of heat sustained by a kiln is due to two causes—namely, conduction and radiation. Amount of heat lost by conduction varies inversely with the thickness of the wall, and depends on the kind of material used. The material should be as porous as possible. Radiation is also of importance. Steel with a sufficient backing of porous material should fulfill the requirements of a casing better that stone. Moreover, it is probably cheaper.

Linings

The lining of the kiln is important wherever lime is burned by the continuous process. The material used for this purpose should be such as will minimize the frequency of repairs. In shape the lining conforms with the sides of the hopper, shaft and sometimes the cooler. Usually it has the same thickness throughout the kiln. If firebrick is used, about 8 in. is generally considered sufficient. Other materials may vary in thickness from 9 to 18 in. In the burning zone the material must resist high temperature as well as the chemical action of the lime.

The temperature in the burning zone probably seldom exceeds 1,400 deg. C., one which many grades of firebrick are able to withstand. The main difficulty seems to be caused by chemical action of the lime. At the temperature attained the lime unites with some constituents of the brick to form compounds which fuse with comparative ease. The apparent failure of firebrick to meet the demands has led to experiments with mica schist and sandstone. Each of these has given satisfaction, but may be more expensive than firebrick. Silica brick warrants consideration in view of the experience with sandstone. Of the five materials mentioned in Table III, paving brick is believed to be the best for the upper part of the lining.

Three methods are in common use for building the tops of kilns. Of the 231 kilns visited in the course of this investigation 91 have open tops, 87 closed tops, and 53 are surmounted by stacks. Closed tops are made of flat steel plates, bolted to the casings. The charging door in the top should be closed air-tight after each charging and sealed shut with lime paste. Where stacks are used, the ordinary round steel variety common in boiler practice is employed. They are generally connected to the casings by short conical sections of steel.

Dimensions of stacks in use at the above plants are: Diameter, 22 to 48 in.; height, 10 to 40 feet. A stack is used principally to increase the draft, thereby preventing the recarbonating of the lime. It must be large enough to deliver the gas without throttling. It should be so connected to the kiln as to offer the least resistance

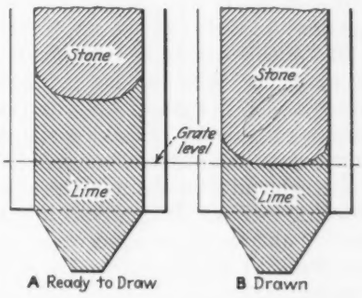


Fig. 6—Vertical sections of shaft, showing method of operation of "following" process

to the passage of gas. Possibly a conical section is advisable.

The hopper or upper part of a kiln is designed as a place where the stone can be stored and at the same time preheated by the waste gases from the kiln. Hoppers are built in the form of inverted truncated cones or pyramids. The larger base is at the top. The cross-section of the upper base must be small enough to give the sides a rather steep slope. It is generally agreed that stone sufficient to supply the kiln for 48 hours is enough to keep on hand.

Shaft kilns are commonly operated by two methods—namely, the "following" and the "sticking" processes. By either process only part of the lime is taken out at a

Table I—Variations in Kiln Design

(Shown in Figs. 1, 2, 3, 4 and 5)

Part of Kiln	Fig. 1	Fig. 2	Fig. 3	Fig. 4	Fig. 5
Casing	Part steel, part stone, brick or concrete	Stone	Steel	Steel	Steel
Lining	Firebrick	Firebrick	Two grades of fire brick	Firebrick	Two grades of firebrick
Backing	Steel section back	None	Has backing	None	Has backing
Top	Closed	Open	Open	Stack	Closed
Charging door	Flat	None	None	Inside of conical piece	Flat
Hopper	Circular at top, elliptical at bottom	Square at top, rectangular at bottom	Circular at top and bottom	None	Circular at top, elliptical at bottom
Shaft	Straight, elliptical	Straight, rectangular	Straight, circular	Conical	Distorted conical
Cooler	Unlined	Lined	Unlined	Unlined	Lined
Means of drawing	Door under center	Door at side	Shears	Shears	Shears
Number of fire boxes	Two	Four	Four eyes for producer gas	Three	Four

time, since enough must remain to fill the cooler and so keep the unburned stone above the grate level. The "following" method is simple. When the lime is drawn from the bottom of the kiln the remaining lime and stone slide down and fill up the space, as would naturally be expected. The difficulty with the process lies in the fact that the stone will not burn evenly. Owing to the tendency of the flame and hot gases to pass up the side of the shaft, rather than into the center, the mass of unburned stone always extends down farther in the center than at the sides, as shown in Fig. 6A. It is customary to draw out enough lime to permit the lowest part of the stone to reach the grate level.

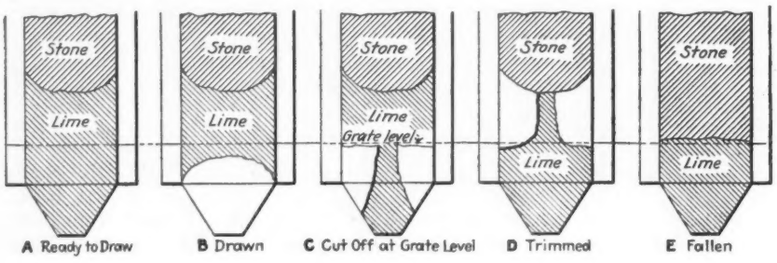


Fig. 7—Vertical sections of shaft, showing method of operation of "sticking" process

In the "sticking" process the kiln is generally chilled by omitting to fire and leaving the fire doors open for from twenty minutes to one hour before drawing. This chilling causes a contraction of the lining and also a solidification of the fused compounds resulting from the action of the lime on the lining. When the lime is drawn from the cooler, these two processes, acting together, prevent the stone from following and cause it to "stick" or "hang" as shown in Fig. 7B. After drawing, the lime is knocked down by bars, inserted through the fireboxes, and finally the whole mass is caused to fall by knocking the supporting pillar of lime away. It must not be supposed, however, that there is a hard and fast distinction between "following" and "sticking" kilns. In general, it may be said that if the sides of the shaft slope outward, the kiln will "follow"; if straight, it will "stick." To summarize, it apparently is more expensive to operate a kiln by the "sticking" than by the "following" process. Owing to the danger of obtaining core or overburned or recarbonated lime, the "following" process probably gives a smaller capacity. It seems to be more economical, however.

The cooler, as the bottom compartment of the kiln is called, seems to be a necessary adjunct of all shaft kilns. Generally it is a pit into which the lime falls from the shaft and from which the lime is removed through an opening at or near the bottom. The height of the cooler in kilns visited varied from 4 to 14 ft.

Unburned stone should be kept above the level of the grates. The easiest way to do this is to leave enough lime in the kiln to support the stone at the required height. Hence, when a kiln is in operation the cooler is always full of lime.

The cooler should actually cool the lime. If possible, the heat so obtained should be utilized, possibly for preheating the air used in burning the fuel. When a lined cooler is used and the lime comes out hot, it must be dumped on the floor, cooled for several hours, and rehandled. If drawn cold, it can be dumped directly into the car for shipment.

Three devices are used for drawing the lime—namely, side-draw doors, center-draw doors, and shears.

The firebox or furnace in which the fuel is burned in limekilns is very similar in purpose and construction to those commonly used under boilers. It is customary to allow one square foot of grate surface for from 12 to 15 lb. of bituminous coal per hour.

Operating Rotary Kilns

Few details need be considered in the operation of rotary kilns. The stone going to the kiln must be cleaned. Furthermore, in many cases the installation of a rotary drier has been justified, especially for drying the fine stone. As for size, stone from ½ to 2 in. has been found satisfactory in practically all rotary installations.

In operating vertical kilns the lime is sorted either while being drawn or when it is taken up from the cooling floor. The object of sorting is to remove all unburned stone or overburned lime.

The time at which a kiln should be drawn will depend upon local conditions and is usually arbitrarily selected.

For producing the draft in shaft kilns, the following methods are in use: Natural draft; forced draft, caused by blowing steam under the grates; induced draft, created by a fan which draws the gas from the top of the kiln; and the Eldred process, according to which a fan takes the gas from the top of the kiln and forces as much of it as is required back under the grates.

In general, it may be said that the best method to be used for creating the draft depends on local conditions, chiefly the kind of stone. If the stone is difficult to overburn, a high capacity and good quality of lime may be obtained with natural draft. If there is danger of overburning, the forced and induced draft will probably give good results. If there is great danger of overburning, or if the lime is likely to act as a flux in the lining, the Eldred process may be used to obtain a good quality of product and keep the repair cost within reasonable limits.

Table II—Dimensions of Casings

Class	Description	Number of Kilns	Dimensions	Maximum, Ft.	Maximum, In.	Minimum, Ft.	Minimum, In.	Average, Ft.	Average, In.
1	Square, stone	23	Length of side, external	20	..	12	..	14	3
			Height	50	..	29	..	40	..
2	Round, straight, steel	134	Diameter	20	6	6	6	10	2
			Height	80	..	16	..	40	..
3	Round, conical steel	15	Diameter at top	8	..	6	..	7	6
			Diameter at fire	10	6	8	6	9	4
			Height	43	..	19	..	36	7
			Height	43	..	19	..	36	7
4	Round, steel and stone, straight	49	Diameter at top	16	6	7	..	11	..
			Side of square at fire	18	6	15	6	17	6
			Height	52	..	23	..	60	..

Manufacture of Hydrated Lime

Manufacture of hydrated lime began about 1900. In 1925 production was over 1,500,000 tons. In this manufacture the following stages must be considered, starting with the burnt lime as it comes from the kilns: Crushing, hydrating, screening, and packing. The object of crushing the product is to produce a larger

surface for the action of the water. Moreover, large lumps would be unwieldy in the hydrator. After crushing, the lime is fed into the hydrator. Here it is mixed with the correct amount of water and agitated until the reaction is complete. It comes from the hydrator as a fine powder, which must be classified either by screens or air separators to remove any core or overburned lime that would not slake. The screened or separated product goes to storage bins, where, if capacity is available, it is deemed advisable to let it age for 30 days. Finally it is packed in bags for shipment.

Table III—Materials Used in Lining Kilns

Burning Zone of Kiln. Material Used	Number of Kilns in Which Used	Upper Part, Material Used	Number of Kilns in Which Used
Firebrick	195	Firebrick (same grade as burning zone)	52
Sandstone	21	Firebrick (different grade)	114
		Paving brick	24
Mica schist	19	Granite	11
		Sandstone	30

Actual slaking of the lime takes place in an apparatus called the hydrator. Theoretically, the only function it has to perform is to mix the lime and water thoroughly and quickly, to prevent burning the lime by local overheating. Just what happens when lime burns during slaking is not well understood. If a lump of lime is given enough water to start hydration, but not enough to complete the process, the unslaked portion will "burn" and become practically useless. Therefore sufficient water must be added and it must be mixed with the lime thoroughly and quickly. Several types of hydrators are used in the plants visited. These are as follows: Clyde, Kritzer, Schaffer, and Carson.

In summarizing, it may be said that as a rule the high calcium limes slake much faster than those containing appreciable quantities of magnesia, and consequently liberate a large amount of heat in a short interval of time. If this heat is not dissipated there is danger of burning, with deleterious results.

American Initiative Abroad

"IN 1912," writes Mr. V. G. Hills in an article scheduled to appear in a forthcoming issue, "C. G. Gunther, supported by Seeley W. Mudd and Philip Wiseman, set out to prospect for ancient mines in the Near East. The expedition was organized on a scientific basis and successfully consummated, but none the less it was a prospecting venture solely. Mr. Gunther visited Cyprus, among other regions, and there found an area he believed should be prospected." A brief historical account of the mines, which were in operation in 166 A. D., serves as an introduction to a description of the application of modern methods and up-to-date machinery for the winning of copper ore in a Mediterranean region little known to engineers.

Revisiting Arizona Mining Camps

PART V

Further Particulars of United Verde Reverberatory Practice—The Verde Central Property

By E. H. Robie
Associate Editor

A RIBBED arch is an unusual feature of the United Verde reverberatory that I did not see elsewhere in the Southwest. The ribs are of silica brick, like the rest of the arch, and are laid across the roof between buckstays only; as the buckstays vary between 2 and 4 ft. apart, the ribs have no definite space interval. Separate skewback plates are used against the ribs. The roof is built of 20-in. silica brick, and the ribs project 15 in. above (9 in. above for the 19-ft. furnaces), giving a total roof thickness of 35 in. at the ribs. A system of offsetting the joints is used to insure a solid roof construction, and the center of the arch, at the top, is keyed when hot. It is claimed that an additional life of the arch is obtained by this method, the ribs supporting the brick between them even when they have become very thin. When dangerously thin, however, another layer of 15-in. brick is added between the ribs, thus making the top of the arch even and smooth. This ribbed type of construction is confined to the smelting end of the furnace, about one-third of the length, where the heat is greatest.

Another smelter manager later told me that he had tried this type of construction, but had given it up because the brick beneath the ribs (where the layer would be 35 in. thick) would burn away unusually quickly owing to slow heat conduction through the thick layer. This resulted in thin spots appearing early along the edges of the ribs, so it was considered that no advantage was gained. It has certainly been successful at Clarkdale, however, as the arches on the 25-ft. furnaces are said to last for 18 to 26 months, and on the 19-ft. furnace from 8 to 10 months, between repairs. Repairs are then usually confined to the first 30 ft. of the arch from the bridge wall.

Weak spots in a furnace roof are nursed more or less during the last days of a campaign at all smelters. At Clarkdale, a water coil mounted on a plate, with the interstices filled with clay, has been placed over such weak spots with fair success. A better method, however, and one that is used quite commonly elsewhere too, consists in merely keeping an air jet blowing on patches that become red hot. The top of a reverberatory roof should, of course, be kept free from accumulated calcine and dust, which act as fine insulating materials, allowing the bricks underneath to get too hot and to wear or melt away sooner than they otherwise would. This precaution would not be necessary if a refractory at a reasonable price were available that would withstand the interior furnace conditions at the temperature there attained. At one smelter where more or less calcine falls on the reverberatory roof, pains are taken to blow off accumulated dirt twice a shift with compressed air, a disagreeable operation for everyone in the vicinity, I would imagine.

The bed for a new reverberatory was being put in while I was at Clarkdale. This was made up of about

2 or 3 ft. of 95 per cent silica quartz, crushed to ¼ in., the dry material being tamped in lightly. The top layer, about 1 ft. thick, is mixed with about 3 per cent of ground fireclay. More than usual attention is paid at this plant to control of furnace feed and product. For example, the coal going to each burner is weighed and the air to each burner is measured with a pitot tube. Four burners are used on the 19-ft. furnace and five on the 25-ft. There is no automatic regulation of the draft, as has been developed at Anaconda, but it is kept at about 0.02 in. of water in the flue. An effort is made to keep the composition of the reverb gases about 17.8 per cent carbon dioxide, 0.4 per cent carbon monoxide, and no oxygen. In actual work, however, the carbon monoxide may get down to zero and the oxygen up to 0.8. A careful traverse of the flue is necessary to get an accurate composite analysis.

A few representative monthly analyses are appended:

	SiO_2	Al_2O_3	Fe	Equivalent FeO	CaO	S	Zn	Cu
Roaster feed	23.5	4.3	27.8	35.7	0.7	28.1	2.7	5.32
Calcine	....	...	....	....	...	9.5	...	....
Reverb matte	0.8 (a)	...	41.3	....	...	24.8	3.7	25.1
Reverb slag	36.6	6.1	38.2	49.1	2.1	1.4	3.3	0.35

(a) Reported as "insoluble."

Converter practice at Clarkdale follows standard lines. Eight 12-ft. Great Falls type upright converters are provided, six of which were in use at the time of my visit. The usual magnetite coating is maintained, so that repairs to the magnesite-brick lining are made at only rare intervals, with the exception of an occasional replacement of brick at the tuyère line and in the caps. Efforts are made to keep the silica in the converter slag up to 20 per cent.

Cast-iron pots are used for slag and cast-steel ladles for matte. The matte ladles are protected in the conventional way by a skull of slag before being used for matte. No lime or other kind of wash is found necessary to facilitate removal of the skulls from the slag pots. Electric welding is resorted to, to a considerable extent, for repairs to the cast-steel pots.

As is usual at most smelters, a permanent record of temperatures at several points about the smelter is kept. Here, Brown recording pyrometers are used to keep track of the temperature at the outlet flues of both the old and new roaster plants; in the brick stack, which handles the roaster gases; and in the exit flues from the waste-heat boilers, this gas, incidentally, running about 550 deg. F. It is planned also to keep a permanent record of the temperature of the converter gas going to the Cottrell plant.

C. R. Kuzell, metallurgist of the United Verde, is a firm advocate of the idea of smelting flotation concentrates in the moist condition, without roasting, though this practice is not adaptable to the direct-smelting ore of the Clarkdale plant, where even with the elimination of almost 20 units of sulphur, still only a 25 per cent matte is made. But where a high-grade, low-iron concentrate is made, he believes the practice to be fully warranted. An important advantage thus usually secured is the elimination of troubles caused by the accumulation of magnetite in the reverberatory. This magnetite is formed largely in the roasting furnace, even where the operation is little more than a drying process. Slag losses are much lower, with the better furnace conditions thus secured, and losses caused by dusting are, of course, almost eliminated when the charge is introduced damp, thus perhaps making a Cottrell precipitator unnecessary. On the debit side of the ledger must be placed a smaller furnace capacity and higher fuel requirements compared with the smelting of hot calcine. The method of feeding the damp material may also prove troublesome.

I understand that at the Trail smelter, in British Columbia, where all of the Allenby concentrates are smelted while still moist, troubles caused by magnetite in the reverberatory have not been eliminated. The concentrate there contains about 35 per cent copper and 10 per cent silica. About 300 tons of charge is smelted per day in the 18x60-ft. reverberatory, the powdered-coal consumption being about 23 per cent.

A daily meeting of all the plant foremen is an interesting feature of the smelter administration at Clarkdale. At 9 a.m. every day, in the office of the smelter superintendent, an opportunity is given to discuss daily costs and losses, and to talk over conditions in all parts of the plant and plan the work for the day. This seems

The town of Jerome, Ariz., as it appears looking up from the United Verde United Verde, shown in

to me an excellent idea, and one that might well be adopted more generally.

The town of Clarkdale, adjoining the smelter, has long been known as a community that is particularly well laid out and managed. To be sure, the overnight visitor has no choice but to partake of the hospitality of "Ma Perkins" at the Dormitory, which I can say from experience is eminently acceptable, or to dine at the Chinaman's, but in the evening he may go to a more sumptuous clubhouse than most city inhabitants enjoy. This $150,000 memorial to the late Senator Clark, built from money that he willed for the purpose, was opened about six months ago, and is without doubt the finest workingmen's clubhouse provided at any mine in the world. The town also boasts a new high school, so that the building, as well as what goes on inside, may live up to the high reputation enjoyed by Arizona's educational institutions.

The Verde Central a Promising Property

The visitor to the Jerome district finds several objects of interest. In addition to the mine, mill, and smelter of the United Verde Copper Company, already described, there is the mine and smelter of the United Verde Extension Mining Company, and the mine of the Verde Central Mines, Inc., now under development. The last-named company is a subsidiary of the Calumet & Arizona Mining Company. Its property, which is under the management of Robert H. Dickson, is on the right of the road from Prescott leading down the mountain into Jerome, perhaps a mile from town. A good waste dump has already accumulated, and I understand that commercial ore is likely to be shipped this year and that construction of a mill is being considered. Unfortunately, time did not permit my visiting this property, but it is well spoken of, development on the Rock Butte fracture zone and on the contact of the quartz porphyry with the greenstone in the south portion of the property being promising. The western end of the property has been disappointing. Over 13,000 ft. of development work was done last year, and almost 10,000 ft. of diamond drilling. Most of the crosscutting and drifting was done on the 1,000-ft. level. In the Rock Butte zone, the 1,750 and 1,900-ft. levels have been opened up. The ore so far developed is highly siliceous, the minerals being pyrite and chalcopyrite. Much of it will assay between 2 and 6 per cent copper.

(The United Verde Extension smelter will be discussed next week)

How Prosperous Is the Metal Mining Industry?

MUCH has been said recently about "profitless prosperity" in the United States during 1927. Large production and turnover with small profits has characterized many industries. What are the facts regarding metal mining? A. B. Parsons, associate editor of *"E. & M. J.,"* has analyzed the annual reports of the important mining companies in North and South America; the results will be published in a statistical article to appear in an early issue.

Zinc Roofing Resistant to Corrosion

IN AN article, contributed to a recent Bulletin of the Imperial Institute and abstracted in *Chemistry and Industry,* H. M. Ridge draws attention to the value of sheet zinc as a roofing material which is highly resistant to corrosion, and considers that the adoption of high-grade zinc sheets for roofing in tropical countries, coastal areas, and industrial districts would be highly beneficial. Zinc sheets used for roofing in the Liége district, under such adverse conditions as a damp climate and numerous chemical and metallurgical works burning coal, are said to have a life of fully 100 years.

Extension Mine. To the far right may dimly be seen the open pit of the more detail last week.

USEFUL OPERATING IDEAS

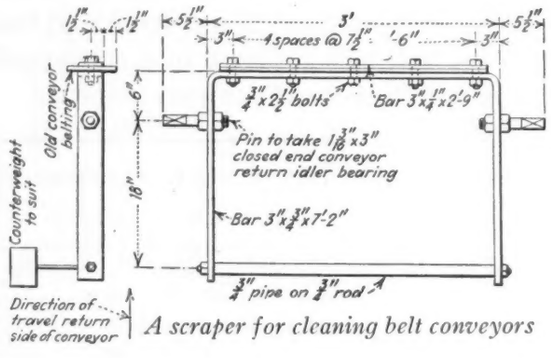
A Conveyor Scraper

By E. H. Oneal

IDEA No. 1

SOME difficulty was experienced by the Old Dominion Company in getting a satisfactory scraper for the waste rock conveyor from the mine until the one shown in the accompanying sketch was tried. As this is somewhat different from any I have seen described as being in use elsewhere, it may prove of interest.

The waste conveyor is made up of odd pieces of belt, some new and some from belt discarded from other conveyors. Cleaning was therefore a little more difficult than if the belt had been of uniform section. The piece of belting used for the scraper is made adjustable by using slotted holes. The size of the counterweight was determined by trial, the weight being varied until satisfactory operation was obtained.


Old conveyor belting
Counterweight to suit
Direction of travel return side of conveyor
Pin to take 1 3/16" x 3" closed end conveyor return idler bearing
Bar 3" x 1/4" x 7'-2"
3/4" pipe on 3/4" rod
Bar 3" x 1/4" x 2'-9"
3/4" x 2 1/2" bolts
4 spaces @ 7 1/2"
3'
18"
6"

A scraper for cleaning belt conveyors

Assaying Ores Containing Insoluble Zinc

IDEA No. 2

ZINC ORES will be met occasionally in which part of the mineral is insoluble. Unless special measures are taken, the ordinary method of assaying will lose this zinc and low results will be obtained. One may always resort to the carbonate fusion method prior to wet treatment. This, however, can be done only at the expense of time. In the succeeding paragraphs E. Leroy Adkins, of Wallace, Idaho, describes a method which he has used frequently on this type of ore with good results. By means of it all insoluble silicates are converted into sulphides and sulphates, which are readily soluble in acid. The method is as follows:

Weigh out the charge as usual in a Pyrex glass beaker, and moisten it slightly with hydrochloric acid and evaporate almost to dryness. Add about the same bulk of flour of sulphur and place the beaker on the hottest part of the plate. A red heat will do no harm. The sulphur will ignite and will be consumed within about one minute. Cool and proceed with the assay in the usual manner, using aqua regia as a solvent.

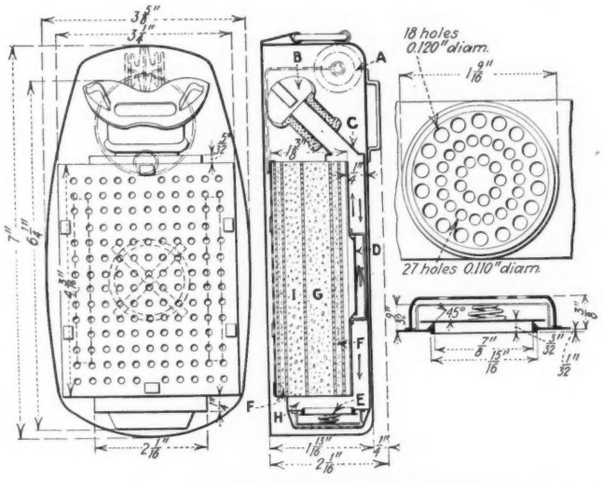
The results obtained by this method check closely those obtained by the tedious carbonate-fusion method. The additional time required will not exceed five minutes.

The Miner's Self-Rescuer

IDEA No. 3

SELF-RESCUERS are pocket-size respirators that protect the wearer from air contaminated with carbon monoxide. They are intended to provide a miner with such protection for at least half an hour, and thus help him to escape from a mine in which a fire is burning or an explosion has occurred. The device is described in Miners' Circular No. 30 issued by the U. S. Bureau of Mines.

The self-rescuer is a small canister made of tin plate to which a mouthpiece is attached. The wearer breathes by mouth and through the self-rescuer; breathing through the nose is prevented by a nose clip. Both the clip and self-rescuer, when not in use, are inclosed in a brass case sealed air-tight with soft solder and having a cover that may be ripped off by hand. This case may be carried in the coat pocket or by means of a loop on the belt.



Details of permissible carbon monoxide self-rescuer

A, nose clip. *B*, rubber mouthpiece. *C*, metal mouthpiece. *D*, inhalation valve. *E*, exhalation valve. *F*, absorbent cotton filter between wire screens. *G*, hopcalite. *H*, wire screen separator. *I*, fused calcium chloride.

When the device is put in use, the air breathed by the miner passes through certain essential parts and materials described as follows with reference to the accompanying illustration:

First, inhaled air enters through small holes in the

canister at the lower side (as held in the mouth) and then filters through absorbent cotton, held between wire screens, which removes smoke. Next is a layer of granular (14- to 20-mesh size) fused calcium chloride (90 cu.cm. or $5\frac{1}{2}$ cu.in. in volume), to absorb water vapor, which is always present in air and destroys the efficiency of the "hopcalite," the material in the next layer. Hopcalite is a granular (14- to 20-mesh size) mixture of specially prepared manganese dioxide and copper oxide; 110 cu.cm. ($6\frac{3}{4}$ cu.in.) is put into the canister. This layer is separated from the calcium chloride by wire gauze. Hopcalite acts as a catalyzer; that is, it causes any carbon monoxide (CO) and oxygen (O_2) in the air that passes through it to unite and produce the relatively harmless carbon dioxide (CO_2).

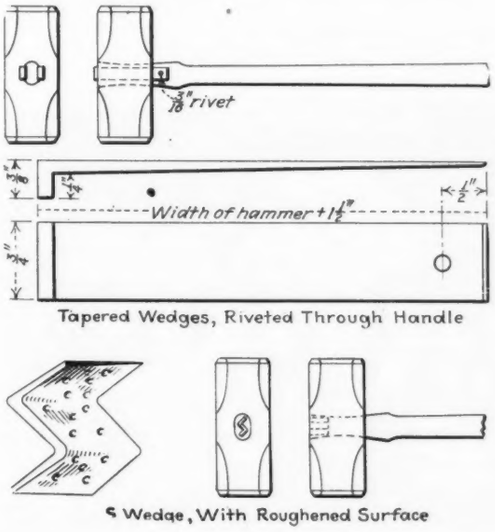
The life of the self-rescuer depends upon the length of time moisture is kept out of the hopcalite. Next to the hopcalite is another filter of cotton between wire screens. The last screen has a cross crimped into it diagonally from corner to corner, so that a space for the passage of air is provided between the tin-plate back of the canister. The air then passes through a mica-disk check valve to a passageway connecting to the mouthpiece. Exhaled air goes through the same passageway and through an exhale valve (mica-disk check valve) at the end of the self-rescuer opposite the mouthpiece. To prevent any carbon monoxide from leaking through the exhale valve and being breathed by the wearer, the mica disk seats against a knife-edge ring that is finished by careful grinding. A small spiral spring keeps the disk in continual contact with its seat when the pressure is low or is reversed, as when the wearer exhales.

Making Fast the Sledge Handle

IDEA No. 4

TWO METHODS for securing the head of a hammer or sledge to its handle are described in the accompanying illustration, taken from a recent issue of *National Safety News*. Glue put on the wedges before they are fastened into the handle aids greatly in holding the head on more firmly. The proper securing of the head in this fashion will be found economical.

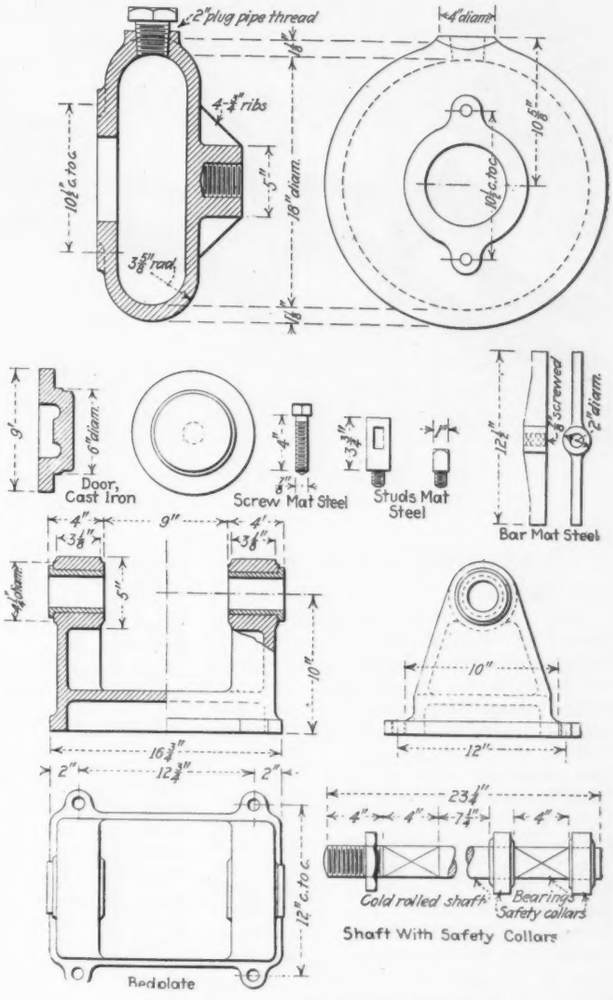
Two ways of securing sledge to handle



Grinding Amalgam

IDEA No. 5

AN AMALGAM grinder used by Dome Mines, Ltd., South Porcupine, Ont., for cleaning concentrates from amalgam is shown in the accompanying illustration. This grinder has also been found useful in breaking up lumpy amalgam, high-grade scale, and other similar materials obtained from traps and sumps in various parts of the water circuit of the mill.

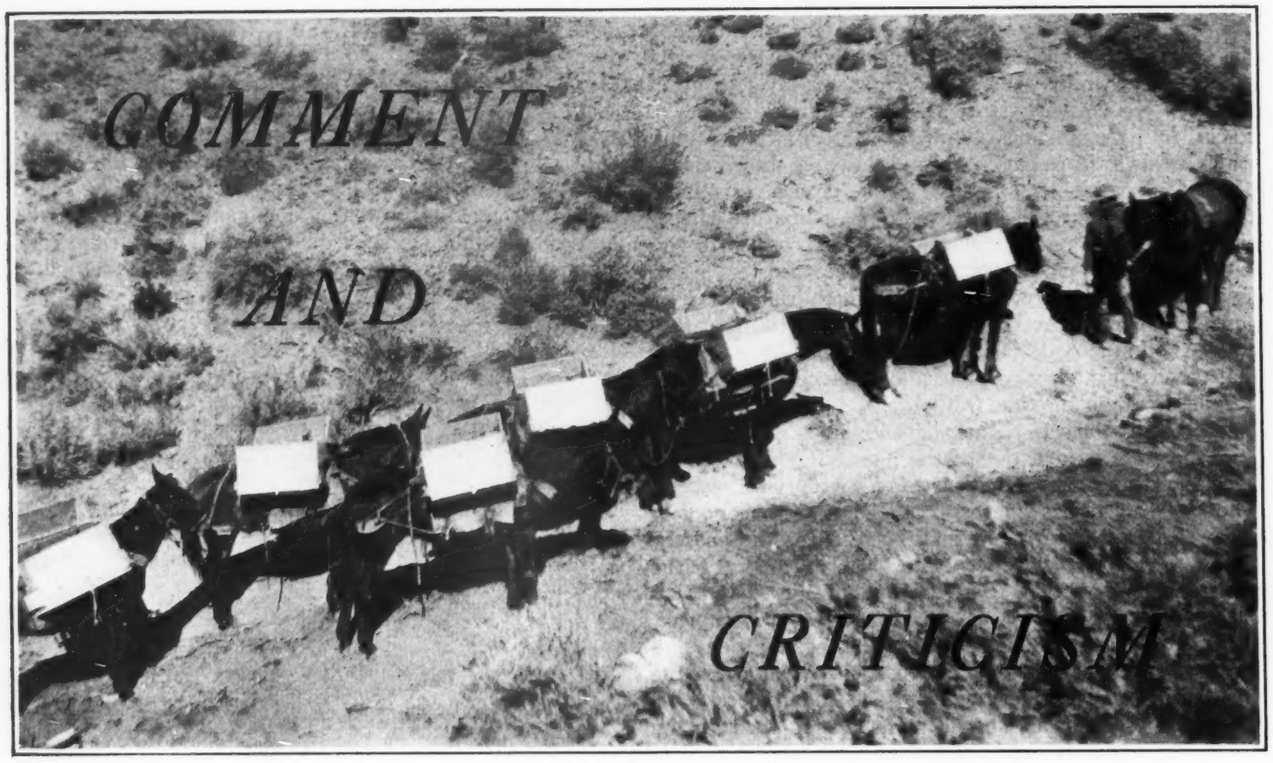


Details of an amalgam grinder

A Corrosion-proof Shaft Gate

IDEA No. 6

AT A CERTAIN MINE extremely acid water trickles down the shaft, the acidity being due to the oxidation of pyrite in the ore. The acid corroded the gates in the shaft stations to such an extent that the hinges and fastenings were always in need of repairs. A gate built entirely of wood was designed, and has given satisfaction. Wood dowels replace all the nails and screws; the bottom of the post of the gate is stepped into a block of wood which has a hole bored into it for the introduction of grease, and the top is held by a similar block. Some gates made in this manner are stepped into the inverted bottom of a glass bottle.



Pack train carrying dumortierite ore from the mine to the railroad at Oreana, Pershing County, Nevada

Dumortierite and Its Uses

THE EDITOR:

Sir—I am sending you under separate cover a copy of the latest Mackay School of Mines bulletin—a monograph on dumortierite, by the staff. The enclosed snapshots show (1) the pack train carrying the ore down to the hillside to the road; and (2) a display of the materials and products manufactured there. The crucible in the center is made from pure dumortierite, without bond. The andalusite-dumortierite products in the various stages of manufacture of the well-known Champion spark plug are also shown. The dishes in the foreground contain 20 per cent dumortierite, and are unusually tough. They can be dropped on the floor without danger of breakage. These details will I am sure, be of interest to your readers.

JOHN A. FULTON,
Director, Mackay School of Mines.
Reno, Nev.

[The bulletin mentioned is No. 2 of Vol. XXII, University of Nevada. It will be reviewed in due course.—EDITOR.]

* * *

The Increased Weight of Rolled Gold

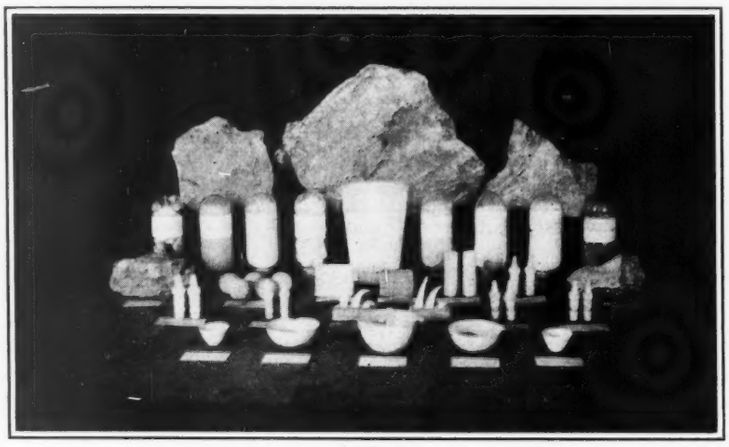
THE EDITOR:

Sir—You recently called attention to the theory of P. G. Nutting that the reason why a lump of gold when rolled out into sheet form weighs more than it does in the original lump is because the greater surface adsorbs more moisture, describing it as "the only explanation possible." It may be the correct explanation, but it is not the only possible one.

Some fifty years ago the late Professor Egleston observed that if he hammered a clean piece of gold on a clean anvil, with a clean hammer, until the gold became brittle from the hammering, it would not then amalgamate with mercury. He announced as "the only possible explanation" that gold when in the strained condition would not amalgamate with mercury. This explanation, made by one of the most prominent metallurgists of that day, stood unchallenged for nearly thirty years, until I investigated the same phenomenon in connection with my doctorate thesis and checked everything Professor Egleston had reported except his explanation, with which I could not agree. I was curious enough to try polishing the brittle but "clean" piece of gold with rouge, and found that after the surface had thus been cleaned it would amalgamate perfectly, though as brittle as before. The surface of the gold had had enough invisible dust and scale worked into it by the hammering operation so that the mercury would not wet it, although it appeared, to the eye, quite clean. Observing it under the microscope the dust particles could be seen embedded in the surface.

Therefore, I should like to have Mr. Nutting repeat his weighing experiments at 110 deg. C. before agreeing that adsorption on the surface is the only possible explanation of the phenomenon

Dumortierite materials manufactured at Oreana, Pershing County, Nevada



he observed. It seems quite probable to me that the rolling operations might imbed enough foreign matter in the surface of the gold to be easily detectable by weighing on a precision balance, though not visible to the eye.

Scarsdale, N. Y. THOMAS T. READ.

[Dr. Read's contribution is most welcome, as throwing additional light on an interesting problem. It is, of course, more than probable that contamination may occur during rolling, and that weight may be increased thus; but he introduces a new subject for discussion in assuming that "polishing with rouge" is synonymous with "cleaning." The polishing would remove one contaminant and add another, because the gloss resulting is due to the adsorption of the rouge by the gold, if one accepts the uncontradicted conclusion of authorities, who assert, moreover, that to remove the rouge would involve the destruction of the polish—assuming, of course, that dry rouge is used.

The improved adhesion of mercury to gold after polishing thus may be due to the removal of foreign matter, to the smoothing of the surface, or to the greater amalgamability of rouged gold, or to any two or to all three of these different factors. When mercury amalgamates with gold something more than adhesion occurs, however; compounds of gold and mercury are formed. The presence of the rouge may stimulate this reaction; the ferric oxide may exert a mild catalytic action—EDITOR.]

* * *

A Metallurgist and His Invention

THE EDITOR:

Sir—William A. Heywood died in University Hospital, London, on April 17. Mr. Heywood's body was cremated —a fitting end for all metallurgists. He was the first metallurgist to produce copper in a magnesite-lined converter, at the works of the Pittsmont Copper Company at Butte, Mont., in 1906. Later he went to Spassky, Siberia. The Pittsmont company was merged with another company, and the process of converting copper in basic-lined converters was abandoned and subsequently introduced by the Peirce-Smith Converter Company.

In 1923 a suit was brought for infringement of patent by the Peirce-Smith company against the United Verde Copper Company, and Mr. Heywood appeared as a witness for the defendant. The court decided that the mere fact of invention without introduction into general practice or use did not constitute a prior right and that the fact that the Peirce-Smith company put it into general use in the art entitled them to a decision in their favor. The Carson side-feed reverberatory case was decided in the opposite manner. Carson had a patent which he did not introduce into general use. Others did, however, and he was given a decision against American Smelting & Refining, notwithstanding the decision in the Peirce-Smith *vs.* United Verde case.

It would be interesting to know, in view of these two decisions, just what constitutes invention.

HIRAM W. HIXON.

London, England.

[Mr. Heywood's career was sketched in "Who's Who in Mining & Metallurgy" (1910) as follows: "Cons. metallurgist; 1883-88—chemist, New Jersey Extraction Works; 1888-91—smelter supt., Fairbank, Wyo., and Copperfield, Vt.; 1891-95—smelter mgr., Quebrada Copper Co., Venezuela; 1895-1900—Anaconda Copper Co. and A. S. & R. Co.; 1900-02—smelter supt., Mond Nickel Co., Victoria Mines, Ont.; 1902-05—smelter supt., Tennessee Copper Co.; 1905-06—smelter mgr., Pittsburg and Montana Copper Co., Butte; 1906-08—cons. met. for North American Lead Co., Mo.; Spassky Copper Mines, Siberia; Namaqua Copper Co., Cape Colony, and Copiapó Copper Co., Chile." —EDITOR.]

* * *

Xanthate and Minerals Separation

THE EDITOR:

Sir—In an editorial on the first page of your April 7 issue, under the caption "Minerals Separation Has a Touch of Adversity," you quote two paragraphs of Judge Bourquin's opinion in Metals Recovery Company against Anaconda Copper Mining Company, and as we know that a publication of your high character would not wilfully attempt to mislead the mining industry, we are writing to you in the premises and take it you will be glad to publish this letter.

Minerals Separation was not a party to the Metals Recovery suit and the validity of its xanthate patents was not in issue. No reference to them was made at the trial, and probably no one would be more surprised than Judge Bourquin himself, were he told that he had disposed of the xanthate patents of Minerals Separation without giving Minerals Separation its day in court.

Our attorneys withdrew as counsel for Anaconda in the Metals Recovery suit when Anaconda concluded that, as a part of its defense to the Perkins patent, it would be to Anaconda's benefit to set up Martin's experiments. We did not "protest" and Anaconda did not "persist," as your editorial says. On the contrary, we felt that in fairness to Anaconda we should let it pursue its policy with an eye single to its own interests, and we voluntarily left it to Anaconda to go ahead as it would.

Our attorneys were fully conversant with the facts as to the Martin experiments, and were of opinion that if these facts were fully developed, they would, far from assisting the defense of the suit, tend to weaken it. To this extent there was a difference of opinion between our counsel and counsel for Anaconda. As we had nothing to do with the trial, the facts as to Martin's experiments and the abandonment thereof were naturally not fully developed.

Anaconda itself, we are quite sure, would be the first to bear witness to our efforts in the introduction in 1923 of the use of xanthate and in proving its value to Anaconda and the mining industry. Martin was in no way concerned directly or indirectly with the introduction of xanthate, and when advised of it, disparaged its utility. Martin's experiments of 1915 were inconclusive and were abandoned by him, nothing further being done therewith either by him or the Utah Copper Company. It remained for Minerals Separation independently of Martin and through Keller and Lewis to invent and develop the use of xanthate and in the language of the United States Supreme Court in the *Hyde* case, again to *"convert experiment into solution, turn failure into success."*

We are satisfied that the mining industry will require more than reliance on forgotten and discarded experiments to withhold recognition to Minerals Separation for that which, with its xanthate patents, it is doing for that industry. While we would regret the necessity of having to go through the lengthy and expensive procedure of enforcing our rights to the use of xanthate, we may well anticipate for it the same recognition which the courts have accorded our previous claims.

Should we for the first time fail to establish the validity of a patent for which we contend, and should your prognostications and prophecies come true, we will then, with a degree of sportsmanship which we trust you will approve, accept your consolatory remark, that a little bit of adversity will be good for our soul.

ALFRED A. COOK,
Vice-president and general counsel
Minerals Separation North American Corporation.

New York, N. Y.

[We are glad to give Mr. Cook an opportunity to present part of his case to our readers. At the same time we cannot agree that anything said in the editorial could "mislead the mining industry"; nor do we see that Mr. Cook makes any effort to point out any essential inaccuracy in the editorial in question.

He says "we did not protest and Anaconda did not persist, as your editorial says." Is this not a quibble? Perhaps no formal protest was drawn up with the appropriate "whereases," but the fact remains that Minerals Separation definitely planned to co-operate with Anaconda in the defense of the case; that there arose, to quote Mr. Cook, "difference of opinion between our counsel and counsel for Anaconda," as to the defense to be used; and that Minerals Separation thereupon withdrew. Granting that Minerals Separation did not "protest," Anaconda certainly persisted.

The following points made in the editorial are unchallenged:

(1) That Minerals Separation withdrew from a joint defense because Anaconda decided to introduce the Martin evidence by which it was shown that

Martin had successfully used xanthate experimentally at Utah Copper in 1915.

(2) That Judge Bourquin in his decision specifically recognized the Martin evidence as a valid defense against the claims of Metals Recovery regarding the use of xanthate.

(3) That this set a precedent which would be a factor in any litigation that Minerals Separation might start, based on the Keller xanthate patent.

(4) That Judge Bourquin's decision doubtless will be appealed, but that appellate courts seldom depart from findings of fact in lower courts, except where error is clearly apparent.

Our observation that "evidently the decision frees the mining industry from the possibility that Minerals Separation might *try* to impose some kind of a tax based on the xanthate patent" apparently was wrong. It seems from what Mr. Cook says that Minerals Separation will try.

Whether Minerals Separation will be more successful than Metals Recovery in discrediting the work of Mr. Martin remains to be seen, but we still think that a little bit of adversity will be good for the soul of Minerals Separation; and we are glad of the assurance that, in such event, it will be accepted in a spirit of good sportsmanship.—EDITOR.]

* * *

Illicit Diamond Buying

THE EDITOR:

Sir—An article in *Engineering and Mining Journal* of April 21 by George Cecil, on diamond digging in South Africa, would lead one to believe that dealing in I. D. B. is punishable by death by being placed in a dungeon cell, there to die. This is not the fact. It is not an easy matter to put down I. D. B. (illicit diamond buying), but no such punishment is given.

Mr. Gardner Williams in his book "The Diamond Mines of South Africa" covers fully both the mining of diamonds from underground and alluvial diggings. It is hard enough to have laws enacted whereby the illicit dealings in diamonds may be stamped out, and such statements as made by George Cecil only serve to poison the minds of the public and interfere with legislation.

Phoenix, Ariz. C. E. ADDAMS.

* * *

Sanna-Bernard Rolls—An Italian Contribution

THE EDITOR:

Sir—In the article by W. T. W. Miller on "Crushing Rolls for Ore and Rock," which appeared in *E. & M. J.* of Feb. 25, Mr. Miller stated that the "Sanna-Bernard Roll" was of French origin. I should like to say that it is not only of Italian origin but also of Italian construction. The Italian mining industry, although it uses machinery made in other countries, is not backward in the study of the problems confronting it. Certainly in contributing the Sanna-Bernard roll it has achieved something of note. O. REPETTO.

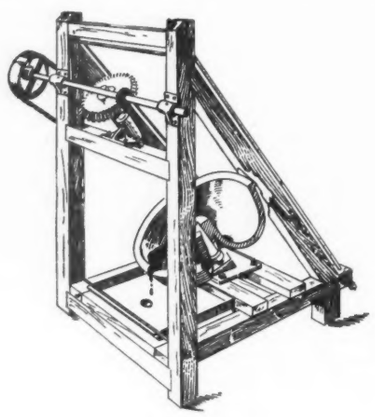
Iglesias, Sardinia.

Consultation

Amalgamating Black Sand

"How would you proceed to amalgamate black sand?"

The Berdan pan is recommended. A preliminary concentration with the prospector's pan is advisable, if the sand be low in grade. The Berdan pan and the manner of using it was described in an article in *Engineering and Mining Journal,* Dec. 21, 1918, p. 1075. In the opinion of the writer, this pan is the simplest type of machine for amalgamating gold in ores and at the same time effecting the final comminution necessary in most cases to free the metal



Detail sketch of Berdan pan

from the incasing gangue and expose it to the action of the mercury. It is used extensively in countries where prospectors and small owners need some machine to clean their pannings and recover the gold in a salable form. The standard size of the pan is about 5 ft. in diameter.

The pan consists of a circular trough which carries a large ball in the manner shown in the illustration. The trough is mounted on a steel driving shaft, set at an angle and so arranged that the pan can be driven by suitable gearing at a speed of from 10 to 15 r.p.m. The material to be ground is fed into the pan either continuously, by means of an automatic feeder, or periodically, by hand; and a stream of water enters with the feed and overflows at the lowest point of the lift, carrying with it the treated material. The fineness to which the latter is ground can be regulated, within certain limits, by adjusting the amount of water passing through the pan

The ball rolls in a pool of mercury, so that any metallic particles that are freed by a crushing action are immediately brought into contact with the quicksilver and amalgamated. The speed of the pan is so low and the action so quiet that practically no mercury is floured during the operation. The capacity of the pan for actual grinding is small, as the ball weighs only about 120 lb. and the power consumed is negligible. It is advisable to break the material in a sample crusher if one is obtainable, before feeding to the pan, so that all will pass ¼ in. mesh. If an even finer feed can be arranged, the duty will be proportionately greater. The secret of success as regards capacity is to maintain an even and minimum bed of ore or other material in the pan. The pan will do practically nothing when overfed.

The operation of panning with the ordinary prospector's pan to effect the preliminary concentration is simple. As described in Peele's "Mining Engineers' Handbook" (second edition, p. 887) it is as follows:

"The pan of gravel is placed in water, the gravel thoroughly wetted and stirred by hand to break up lumps of clay, and the larger stones are picked out. The pan, still under water, is then given a shaking or gyratory motion, which brings the light material to the surface and allows heavy particles to settle; at intervals the pan is tilted and the surface material washed off. These processes alternate until nothing but gold and a little heavy sand is left, which is dried and the gold separated by flowing, or by a magnet (for black sand), or mercury is added to collect the gold as amalgam. In experienced hands there is little or no loss of gold."

By the Way

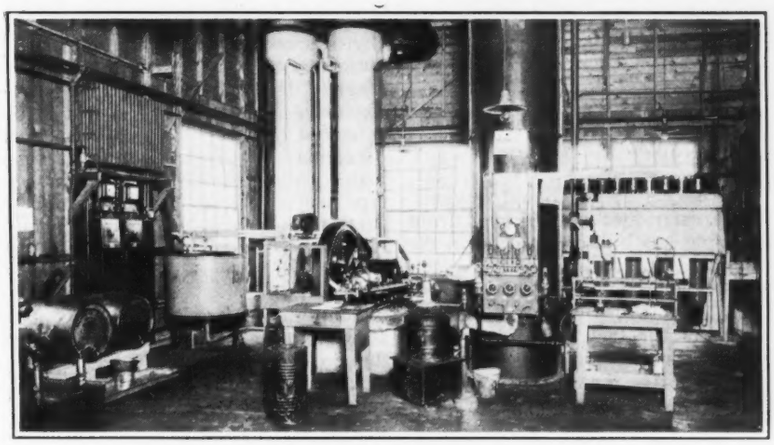
Making Underground Work More Attractive

ONE might think that a mine is no place for a woman to work, least of all a coal mine, but after reading the report of Amritlal Ojha, vice-president of the Indian Mining Federation, one can easily perceive that it indeed must be a cruel government that is considering the prohibition of female labor in Indian mines. It seems that the husband digs up the coal and the wife fills the tubs, presumably finding that task easy through generations of experience in doing the family washing. "By this arrangement," Mr. Ojha says in *The Mining Journal,* of London, "they not only keep up their full earning at the pits but also add to their income by doing work in the fields, all the time enjoying the benefits of their labor in the midst of their family." Does the Indian government not know that even in the great city of New York many wives complain that they see less of their husbands than do their stenographers? Probably some Indian miners' wives would be glad to be thus rid of their husbands' company for a time, but such unfortunate family conditions might be remedied by other means than prohibiting co-operative work. Mr. Ojha goes on to say that if the proposal becomes a law the laborers would then leave the mines for work in the cotton and jute industry, or satisfy themselves on half meals and die by inches.

INDUSTRIAL PROGRESS

Some Recent Developments in Blasting With L.O.X.

By Don B. McCloud
110 South Dearborn St., Chicago, Ill.



An oxygen-liquefying plant with a compressor in the far corner

THE first public demonstration in the United States of blasting with liquid oxygen explosive took place Feb. 7, 1923, at the quarry of the Kelly Island Lime & Stone Company, near Martinsburg, W. Va. On this occasion tests arranged by the U. S. Bureau of Mines were conducted by Adolph Messer and M. Keith Dunham. These tests were described by A. H. Hubbell in *Engineering and Mining Journal-Press* of Feb. 17, 1923. Since then, much experimental work with liquid oxygen explosive (known as L.O.X.) has been done by various organizations, including the Keith Dunham, Air Reduction, and Ingersoll-Rand companies. Although widely used in Europe, L.O.X. was adopted slowly in the United States, and only within the last year has the new explosive really become established in this country.

It is not the purpose of this paper to go into the technical details of L.O.X. These have been discussed in past issues of *Engineering and Mining Journal* and in the *Transactions* of the A.I.M.E., and the Bureau of Mines has published comprehensive booklets covering its investigations of the practical applications of L.O.X. It can be assumed, therefore, that the reader knows that L.O.X. is simply a mixture of carbon and liquid oxygen and that the explosive force results from the almost instantaneous combination of these two substances to form carbon dioxide.

Among those who have become interested in L.O.X. are certain operators engaged in coal stripping. At some strip mines a considerable amount of rock exists in the overburden. In such operations large quantities of explosives are necessary to break this rock properly so as to prepare the way for the Coal Company, Elkville, Ill. These shovels are equipped with 6- or 8-yd. dippers, although recently 12-yd. shovels have been introduced, and at present a 15-yd. machine is almost ready to begin work. The stripping shovel is the vital factor in any strip pit. When the overburden is well broken, the shovel can handle a much greater yardage than when tight rock or large boulders are encountered. Coal production is dependent entirely upon the progress of the stripping shovel.

L.O.X. was introduced in the coal-stripping industry in 1926, and met with success. The real pioneers were the Norton Coal Mining Company, at Nortonville, Ky., and the Black Servant Coal Company, Elkville, Ill. These companies installed L.O.X. plants in 1927 and are using 99 per cent pure liquid oxygen and acetylene-black cartridges, a powerful and satisfactory combination. Any doubt as to the safety, economy, and practicability of L.O.X. has been fully answered by the success of the blasting at these two strip mines.

In a paper published in the April issue of *Coal Age*, Mr. A. M. Nielsen, general superintendent of the Norton company, states that the use of L.O.X. has reduced their shooting cost from 30c. to 15c. per ton. At the Black Servant Mine, at Elkville, costs of explosive have been cut from 13c. per ton when using dynamite, to 5c. per ton with L.O.X. These figures are compiled after the usual practice in the coal-stripping industry, which is to charge all cost items against the tonnage produced and figure costs per ton accordingly. It is evident that owing to the changing nature of the overburden, some

L.O.X. containers, with compressor in the background

months will find the stripping shovels digging in more rock than other months. The foregoing figures, however, represent an average over a five-month period when blasting was done with L.O.X. and a previous five-month period when it was done with dynamite.

It is natural to inquire why it is that L.O.X. can show such economy in strip-mine blasting. The primary reason is that the total cost of L.O.X. at each of these installations is approximately 7½c. per pound, which includes all fixed charges against the plant installation. The quantity of L.O.X. required for a shot is less than that of the 40 per cent dynamite formerly used. Also the comparative strengths of L.O.X. and dynamite are hard to determine in actual field work.

Lowering an L.O.X. cartridge down a churn-drill hole, after soaking the carbon cartridge in liquid oxygen in the box on the wagon. Note the evaporation

As a result of the sudden, powerful shock produced by an L.O.X. explosion, the rock in the overburden is shattered to a greater extent than was the case before the new explosive was used. Boulders are practically eliminated, thus increasing the progress of the stripping shovel. Since the introduction of L.O.X. at the Elkville mine, about 90 per cent of the rock goes through the dipper of the stripping shovel, a condition which has not existed heretofore.

Churn drills are used at practically all strip mines, and the spacing of drill holes is entirely dependent upon the depth and character of the overburden. According to published reports of one of the early L.O.X. installations, drilling costs increased greatly when the new explosive was used, on account of the necessity of spacing the drill holes closer. This has not been the condition at the two mines mentioned. Drill holes are placed, if anything, a little further apart than when dynamite was used. This may be the result of use of the combination of 99 per cent pure liquid oxygen and acetylene-black cartridges.

The Field for L.O.X.

Open-pit mines and quarries where drilling is done with churn drills constitute the immediate field for L.O.X. It is used successfully in underground operations abroad, and possibly it will get into this class of work in this country, but inasmuch as the start has been made at open-pit mines, this field will be the first to develop.

Churn-drill holes from 4 to 8 in. in diameter are preferable when blasting with L.O.X., because they permit the use of large-diameter cartridges which have a much lower evaporation rate than smaller ones. The cartridges commonly used at coal strip mines are about 5 in. in diameter and 20 in. long. They contain 2¼ lb. of acetylene black, which in turn absorbs 11¼ lb. of liquid oxygen. When the cartridges are removed from their dipping box and dropped down the drill holes, evaporation of the oxygen begins, and they must be fired within one hour to get an effective explosion.

Because of the fact that no tamping is required, loading the holes is simple and quick. After the charge has been dropped down the hole, a few shovelsful of dirt is usually dropped on top of it but not tamped. A round of sixteen holes, each charged with 100 lb. of L.O.X., can be loaded and fired within 25 minutes.

It is not feasible to store liquid oxygen for more than several days; hence the use of L.O.X. implies a fairly regular blasting schedule. At coal strip mines it is customary to blast every day or two at each pit, because drill holes ordinarily will not keep open longer than this in some types of overburden. This is an ideal condition for L.O.X., which can be produced in quantities required to meet the daily demands.

L.O.X. installations are made in various types and sizes. The liquid-oxygen producing plants owned by the Norton and the Black Servant companies slightly exceed their rated capacity of 100 lbs. per hour. Neither of these plants runs to full capacity. Sometimes the liquid produced with two or three days' operation is sufficient to supply a week's explosive requirements.

The question of how much explosive must be used to justify installing an L.O.X. plant cannot be answered definitely. Local conditions must be considered. A general rule is that when expenditures for explosive amount to $2,000 per month, appreciable savings can be accomplished with L.O.X. Of course there are exceptions.

The first open-pit metal-mining company to adopt L.O.X. was the Chile Exploration Company. In the Sept. 17, 1927, issue of *Engineering and Mining Journal*, Mr. Burr Wheeler, of that company, said:

"Another change is the gradual adoption of liquid oxygen as virtually the only explosive to be used in the mine. We are convinced that this is the thing, and as rapidly as the equipment for preparing the explosive can be installed we will increase the use of it, until other kinds of explosives are put in the discard."

In line with this statement, the Chile Exploration Company is preparing to install two liquid-oxygen producing units, each of twice the size of the same type as those owned by the Norton and the Black Servant companies.

L.O.X. From a Safety Standpoint

The explosive is made when the porous acetylene black is saturated with liquid oxygen. Inasmuch as the cartridges are not saturated until required for use, there is no hazardous storage problem. Separately the ingredients are harmless. Bags of dry acetylene black are no more explosive than bags of charcoal or soot.

Liquid oxygen, though the supporter of combustion, is by itself non-inflammable. This liquid is stored in vacuum type containers until required for saturating the cartridges. The temperature of liquid oxygen is minus 182 deg. C. and it will freeze practically any substance it touches. Workmen handling it must necessarily be careful not to allow it to splash on their clothes, and the cold saturated cartridges must be handled carefully to avoid freezing the hands. However, less danger is involved in handling liquid oxygen than in handling many kinds of acids or other corrosive substances.

Experiments indicate that a saturated cartridge made of acetylene black can be exploded only upon detonation. There is no record of such cartridges being set off by shock such as occurs when they are dropped down a drill hole or during transportation. The cartridges, if lighted, will burn violently, but will not explode without positive detonation.

It has been mentioned before that cartridges must be detonated within an hour after the holes are loaded, because of the deterioration which occurs through evaporation. If a hole is missed, it is allowed to remain untouched for about four hours. At the expiration of this time all the liquid oxygen will have evaporated, leaving only dry acetylene black in the hole. This dry black is not explosive, so the missed hole can be dug into or cleaned for reloading without hazard.

Summary

1. L.O.X. is being used successfully in coal-stripping operations in the United States.

2. This new explosive has been found to be a cheaper and more efficient blasting medium for strip mines than powder or dynamite.

3. In my belief the most effective L.O.X. consists of acetylene-black cartridges saturated with 99 per cent pure liquid oxygen.

4. The apparent field for L.O.X. is open-pit mines or quarries where churn

drills are employed, thereby permitting the use of large-diameter cartridges, and where a sufficient amount of blasting is done regularly so as to warrant investment in an L.O.X. installation.

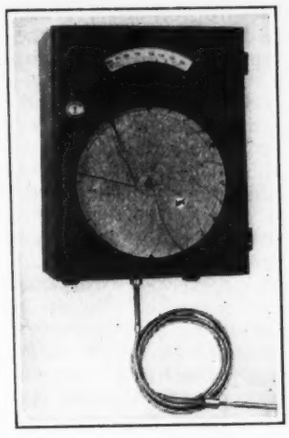
5. The 5-in. diameter cartridges ordinarily used must be fired within approximately one hour after they are placed in a drill hole, but loading can be accomplished quickly and well within the prescribed time, owing to the fact that very little stemming and no tamping are required.

6. L.O.X. requires positive detonation and possesses certain superior safety features.

The Equipment Review

Instruments

A new recorder and contacting controller is being offered by the Bristol Company, Waterbury, Conn. It combines in one case the features of a strongly constructed recorder and a thermometer controller. It is shown in one of the accompanying cuts. The mechanism consists of a single pen-recording system



A combined recorder and thermometer contacting controller

with the controller system and scale mounted directly above it. This instrument is arranged for a contact capacity of 1,000 watts through the agency of self-contained automatic switches. It may be easily connected to line and control apparatus. Because of its large current-carrying capacity, the instrument may be used in many applications without relays.

Motors, Switches

Motor equipment recently announced by General Electric includes a complete new line of d.c. motor starters intended for general purposes; also a new magnetic switch suitable for throwing squirrel-cage motors directly across the line or for use as a primary switch for a wound-rotor motor, the secondary of which is handled by a drum controller. The starters referred to are divided into five types bearing the designation CR-4065, CR-4066, CR-4166, CR-4068, and CR-4168. The magnetic switch is designated CR-3006-D-31.

A new across-the-line starter for a.c. motors has been introduced by the Cutler-Hammer Manufacturing Company, Milwaukee. It is operated by hand. Among its advantages, according to the manufacturer, are: Overload cutouts giving complete motor protection; cadmium plated, double-brake, roller-type contacts; and a small safety dust-proof case. The roller-type contact breaks the arc in two places, giving several times the life of ordinary contacts. The rollers also turn after each operation, thereby presenting a new contact surface for the next operation.

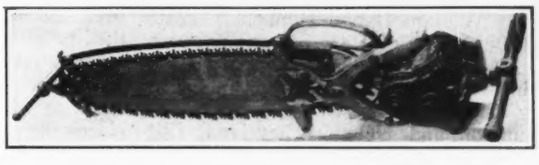
Compressed Air

An air filter for cleaning the air used in cooling large motors as well as the intake air of compressors has been introduced by the National Air Filter Company, Chicago. The dirt-collecting medium employed is a blanket of cellulose material consisting of a mat of many layers of extremely fine cellulose fibers. By this medium minute particles of solid matter are removed, and particles of oil and soot as well. The filter is a built-in unit 12x24x24 in. in dimensions, with a capacity of 1,000 cu.ft. of air per minute. The company has also developed a continuous filter using a dirt-collecting medium of the same type.

Carpenter Shop

The "Wolf" portable timber-sawing machine, which was introduced last year by the Reed-Prentice Corporation, of Worcester, Mass., may now be had equipped with an Ingersoll-Rand Type-A air motor. The machine can handle timber 24 in. in diameter. It weighs 95-lb. It will operate at 80-lb. air pressure.

Another machine for the carpenter shop is the portable electric hollow chisel mortiser (No. 9 Wallace), which has been introduced by J. D. Wallace & Company, 134 South California Ave., Chicago. This machine will do the highest caliber of work on square holes up to ½-in. diameter. It is operated at 3,450 r.p.m.



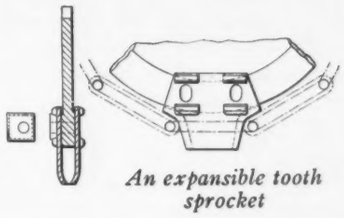
Timber-sawing machine equipped with an air motor

Gas Engines

The heavy-duty industrial engines of the Climax Engineering Company, Clinton, Iowa, are now being equipped with an automatic spark control. A novel principle of operation is employed, the control being operated from the suction in the intake manifold. As the variation in pressure in the manifold is proportional to the load imposed upon the engine, according to the manufacturer, the ignition is always timed correctly. This device, it is said, will reduce wear on the bearings.

Transmission

One of the accompanying illustrations shows a device intended to increase the life of sprocket chains. This is the expansible tooth sprocket introduced by the Union Chain & Manufacturing Company, Sandusky, Ohio. The teeth of this sprocket may be adjusted from time to time to take up the natural wear of the chain links. After the chain has



An expansible tooth sprocket

elongated so that it no longer fits properly on the sprocket, it may be adjusted by releasing the nut and readjusting the eccentric blocks of the sprocket so as to expand the teeth to the next larger pitch diameter.

BULLETINS

ROD MILLS—Allis-Chalmers Manufacturing Company, Milwaukee. Bulletin No. 1821-B, twenty-four pages.

BELTING—Alexander Bros., 14 South St., Philadelphia, Pa. A 16-page bulletin on "Tentacular" belting. This belting has high adhesion on pulleys—so much so that it will pull like a chain, according to the claim of the manufacturer.

PUMPS—Aldrich Pump Company, Allentown, Pa. Bulletin No. 70, of 16 pages. Double-suction volute centrifugal pumps.

AIR PREHEATERS—Combustion Engineering Corporation, 200 Madison Ave., New York. Catalog AH-3; twenty-four pages. The C-E air preheater.

POWER SHOVELS—Austin Machinery Corporation, 3019 Lake Shore Drive, Muskegon, Mich. "Wolverine" one-yard shovel; thirty-two pages.

STRUCTURAL REPAIRS—Stone & Tar Products Company, 97 South 6th St., Brooklyn. A 46-page pamphlet on waterproofing materials, caulking compounds, and cements of various sorts.

COMPRESSORS—Ingersoll-Rand Company, New York. "One Hundred and One Ways to Save Money with Portable Compressors." Comprises 112 pages.

PNEUMATIC TOOLS—Chicago Pneumatic Tool Company, New York. Catalog No. 561, of 70 pages. Pneumatic tools and accessories.

FLOODLIGHTS — Crouse-Hinds Company, Syracuse. Catalog 310, of 46 pages. Floodlights and industrial lighting units.

NEWS OF THE WEEK

Summary

THE VISIT of Prof. L. C. Graton, of Harvard, to Johannesburg has brought the question of the future of mining at depth on the Rand to the fore. J. E. Healey, consulting engineer for Village Deep, the world's deepest mine, recently issued a pessimistic report on the future of the enterprise. Page 786.

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House Committee on Mines recommends acceptance of bill to provide funds for research in reducing potash-production costs. Page 785.

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Midas Gold is making an excellent recovery at its mill at Libby, Mont. Only 30c. of gold per ton is lost in treatment. Page 788.

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McIntyre Porcupine is now producing gold at a depth of 3,375 ft., the lowest gold-producing level in Canada. New mill will probably be erected to handle the output from the new shaft. Page 789.

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Whitedelf Mining, largest silver-lead producer in Bonner County, Idaho, is sinking its shaft to 400 ft. The company is shipping ore steadily to the Tacoma smelter. Page 788.

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Milk Maid Mining, in the Silver Lake district of Utah, is resuming development operations. Page 787.

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The first unit of Sullivan Mining's electrolytic zinc plant is approaching completion. Electric power was turned on recently. Page 785.

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Benguet Consolidated, operating in the Philippine Islands, is building a 100-ton mill at the Balatoc mine, in which it recently acquired a 60 per cent interest. Page 789.

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San Janvier, Sonora, Mexico, is an isolated mining camp being developed by American capital. Three mines are either producing or being prepared for production by Americans. Page 786.

Yuba Associated Engineers Operating Dredges of Anglo-Oriental

California Firm, Long Prominent in Alluvial Gold Mining, Is in Charge of Operations of Tin Dredges in Malay, Siam, Burma and Nigeria

WITH the announcement of the newly organized Anglo-Oriental Mining Corporation, Ltd., of London, it is disclosed that the Yuba Associated Engineers (W. P. Hammon, Newton Cleveland, and their associates), of San Francisco, is identified with the mining interests of the same corporation. The tin-mining interests of Anglo-Oriental Mining are world-wide. Through their subsidiaries and associated companies they control large operating tin mines in the Malay States, Burma, Siam, Nigeria, and Japan, and incidentally in Cornwall, as well as the Penpol smelter, at Liverpool.

The Anglo-Oriental group has been engaged in tin mining for several years, its most successful operations apparently having been in Burma. Recently its interests were extended in tin production in the Far East. Thus, the associated interests become one of the largest tin-producing groups of the world. As evidence of a farsighted policy, they have joined with the Yuba interests of California, which for the last 25 or 30 years have been continuously the most successful dredge operators in alluvial gold mining and have built up a technical corps of engineers.

The Yuba engineers have already undertaken the responsibility of the operations of the various properties involved, and are now represented by Gerald H. Hutton as general manager of the Far Eastern operations, including the Straits Settlements, Siam, and Burma, with headquarters at Ipoh, Federated Malay States. Hutton sailed recently from San Francisco for the Far East. Nelson Dickerman has been engaged as general manager of the operations in Nigeria, and H. Robert Edwards is resident engineer at the London office of the company.

At present the most extensive alluvial tin operations are in the Far East. The Anglo-Oriental people have been maintaining a large development and operating organization in that territory.

Sir William Daniel Henry, chairman of the board of Tin Selection Trust, Ltd., one of the Anglo-Oriental subsidiaries, stated some time ago, in speaking of the new association with W. P. Hammon and Newton Cleveland, that the former had been a leading operator since gold dredging began in California and that the latter was a pioneer in dredge construction and practice. The two were executive heads of the Yuba group represented by the Yuba Consolidated Goldfields that began active dredging operations in 1904 and which has already handled upward of 375,000,000 cu.yd. of alluvial gravel. The Yuba Manufacturing Company, also representing the group, has constructed 62 out of a total of 132 dredges built in California during the first quarter of this century.

Greater progress toward systematic methods is being made in the present known tin deposits, particularly in the Federated Malay States. Well-designed and strongly constructed machinery is necessary to cope with severe operating conditions arising from great depth of dredging. Inadequate equipment is perhaps responsible for as much as 25 per cent of areas being left unworked in some instances. In the Kinta Valley of the Federated Malay States, where one-sixth of the world's tin production originates, dredging and modern practice are displacing hand methods, but unit costs are high, reaching an even 10c. per cubic yard, whereas in the California dredging areas Yuba dredges average less than 5c. per cubic yard. Tin dredges handle 90,000 to 150,000 cu.yd., and in the gold-dredging areas 350,000 cu.yd. are worked per month. It is expected that results comparable with California practice will be attained in tin dredging by the new combination of financing and operating and manufacturing ability.

Old Quebec Gold Field Will Be Developed

Chaudiere Gold, a syndicate of American and Canadian interests, will develop the De Lery property, in southern Quebec, said to be the oldest gold field in the province. The property extends 6 miles on each side of the Chaudiere River for a distance of 9 miles. An estimate of production from this field places the total at about $2,000,000.

House Mines Committee Favors Potash Development

By Paul Wooton
Special Washington Correspondent

THE Committee on Mines and Mining of the House of Representatives reported favorably, on May 3, the bill of Representative Winter authorizing an appropriation of $50,000 a year, for three years, for "chemical, engineering, and manufacturing research, and employing clerical and technical assistants to determine more improved methods and cheaper processes for recovering potash from the leucite, alunite, and other potash-bearing deposits in the United States." The report of the committee, recommending that the House approve the bill, among other things says:

"Evidence at the hearings showed that the result of prior legislation and the drilling campaign conducted thereunder had disclosed the presence of potash deposits thick enough to provide quantity. One is at a depth of something over 1,400 ft. and the other at a depth of 1,900 ft. The potash is in the form of a hard salt known as polyhalite, which has a potash content, when pure, of 15.6 per cent K_2O. It is soluble in water, is combined with salts which are either neutral or beneficial and hence requires no treatment other than crushing or grinding to be used as a direct fertilizer. Unfortunately, however, the polyhalite disclosed in the wells of New Mexico and Texas is not pure. It thus becomes apparent that while the prior legislation is bearing fruit in the locating of new sources of potash deposits, these very deposits must be subjected to study and experiment in order to devise the method of treatment cheaper than any now known in order to make such deposits commercially available.

"If a cheaper process can be found for the extraction of potash from certain forms of deposits found in this country, the United States could be made absolutely independent of foreign sources of supply. Some of these deposits are the leucite volcanic hills in Wyoming running from 10 to 12 per cent potash and 10 to 12 per cent alumina, with silica and other byproducts.

"Our whole problem of potash for cheaper fertilizer depends for its solution upon one thing only—the discovery of cheaper processes of extracting K_2O from our numerous known deposits. There can be little doubt that sooner or later such a chemical process will be revealed.

"It is, therefore, within our own power, by the adoption of this legislation, and by special application, directed and made possible by appropriations to be authorized under this act, to bring about the long desired results. It is clearly a part of good business, good judgment, enlightened self-interest and security to pass this legislation."

"Teamwork" Keynote of U. S. Chamber of Commerce Convention

THE Chamber of Commerce of the United States opened its sixteenth annual convention at Washington, D. C., on May 8, with a record attendance, which included an exceptionally large representation of leaders in industry. A notable feature of the first day's session was the address of Edwin B. Parker, chairman of the Chamber's board of directors, who spoke on "Teamwork for Prosperity." On May 9 Edward J. Mehren, vice-president of the McGraw-Hill Publishing Company, delivered an address before the Department of Manufacture, on "Teamwork for Profits in a Buyers' Market." Abstracts of the notable addresses of the sessions will appear in *Engineering and Mining Journal* of May 19.

La Luz Mine Was Destroyed by Rebels

CABLES received at the offices of the La Luz y Los Angeles Mine Company, in New York City, state that the La Luz mine, in the Pis Pis district of Nicaragua, recently captured by forces supposedly allied with the Nicaraguan rebels under the leadership of Sandino, has been destroyed. The loss of the mine is put at about $2,000,000 by J. Gilmore Fletcher, president of the company.

The mine was blown up on April 24, according to these reports, which have been confirmed by Secretary of State Kellogg. George B. Marshall, assistant manager of the mine, who was captured by the rebels, is still alive. A detachment of marines led by Harry Amphlett, superintendent of the mine, is reported to be on its way back into the jungle in an attempt to rescue Marshall.

Chamber of Commerce Urges More Mine Research Work

THE natural resources group meeting at the sixteenth annual convention of the National Chamber of Commerce voted to accept a resolution offered by Judge Tyson S. Dines, of the Denver Chamber of Commerce, which would increase the research work of the Bureau of Mines. This resolution points out that since future mineral reserves are in deep deposits which would require large outlay of capital to develop, the Bureau of Mines and the Geological Survey can greatly aid the situation by enlarging their research activities, thereby attracting interest and capital to the undertaking. The resolution reads:

"Be it resolved that the Chamber of Commerce of the United States be requested to call the attention of Congress and other departments of our government, including the Bureau of the Budget, to the manifest inadequacy of the appropriations for proper helpful research activities by our Geological Survey and our Mining Bureau under existing conditions, and that they use every effort to impress upon Congress and these departments the great necessity for maintaining the Geological Survey and the Bureau of Mines at the highest degree of scientific efficiency."

Three Options Taken in Smithers, B. C., District

J. J. O'Brien, of Philadelphia, recently took an option on the Mountaineer and other mineral claims of John Watt in the Smithers, B. C., dictrict. These properties adjoin the Victory group, on Hudson Bay Mountain, and have not as yet been thoroughly explored. The consideration is said to be about $60,000.

The Harvey group in the Babine Range, 12 miles from Smithers, has been optioned by Gale & Lifton, a Smithers firm. The property has been developed by tunnels and shafts, and it is reported that a large body of silver-copper ore has been proved.

Frank H. Taylor has optioned the Silver Queen group at Owen Lake from Dr. H. C. Wrinch. The property was optioned and developed by Federal M. & S. in 1923 and 1924, but that company did not exercise the option.

Sullivan Electrolytic Plant Nears Completion

The Sullivan electrolytic zinc plant at Kellogg, Idaho, is rapidly nearing completion, and according to present expectations should be in operation by the latter part of June. This will be the first of three units, each with a capacity of 50 tons of zinc a day. The plant is being built by Sullivan Mining, the stock of which is owned equally by Hecla Mining and Bunker Hill & Sullivan.

On April 22 the switch which connects the electric motors and generators of the plant with the line of the Washington Water Power Company was closed. There are two motor generator sets, each of which consists of a 6,000-hp. motor directly connected with two 2,000-kw. d.-c. generators which will deliver 8,000 amp. at 500-volt pressure.

Champion Copper to Explore in Michigan Copper Country

CHAMPION COPPER will explore 5,000 acres of mineral lands to the north and west of its Champion mine, in the Michigan copper district. This territory has not been explored before, because of divided ownership, but it has recently been entirely turned over to Champion Copper by Copper Range and St. Mary's Mineral Land, equal owners.

The New Baltic shaft of Arcadian Consolidated is now down to 1,650 ft. Drifting from this shaft will probably start about June 1.

San Janvier, Sonora, Is an Active Mining Camp

THREE mines, all operated by Americans, in the San Janvier district, State of Sonora, Mexico, are being actively developed at present. San Janvier is 110 miles by automobile road from Hermosillo. Concentrates and ores are shipped by muleback to Toledo, on the Yaqui River branch of the Southern Pacific, 12 miles from San Janvier.

J. A. Hilton and associates are producing about 20 to 30 tons daily of silver-gold ore at the Las Animas mine. The capacity of the mill will be increased as soon as the new machinery, already on the ground, is installed. The Las Animas mine has been worked at intervals for the last hundred years. Since 1910 it has produced about 6,000,000 oz. of silver and $250,000 in gold. Most of the commercial ore is being taken from between the 400 and 500 levels.

Charles E. Eagan has completed unwatering of the upper levels of the Las Bronces mine and is preparing for development of the Bronces vein and the Crucecitas vein, which parallels it. These mines have been abandoned since about 1860. Ore is reported to be high grade.

G. A. Joslin and associates, of Los Angeles, have taken an option on the Santa Rosa group. This group is situated on the Santa Rosa vein, which in reality is a continuation of the Las Animas vein, and two other parallel veins, the Tasta and the Central. All three veins were worked for oxidized ores in the past, but have been developed only to a slight extent in the sulphide zone. It is probable that the same conditions will be found here as in the Las Animas mine, where commercial ore is found to a depth of 900 ft.

The vertical shaft is now 260 ft. deep. Present plans call for unwatering of the shaft and extension of the drifts on the 150 level underneath old surface stopes and crosscuts driven to the Tasta and Central veins. On the 230 level a crosscut which has cut the Tasta will be extended to cut the Central and another crosscut will be driven back to the Santa Rosa vein, which, at this level, has dipped out of the shaft.

Delaware Mining Plans to Build a Mill Near Silverton

Delaware Mining, in the Silverton district, recently acquired the Born group of claims in Maggie Gulch. Albert Z. Mageda, president of the company, is said to be making arrangements for the construction of a mill, as enough ore has been blocked out to justify that equipment.

The Rawley mine, near Bonanza, Colo., in the San Luis Valley, has shut down for three weeks to place a settling tank to take care of tailings from its mill. Farmers were complaining of water pollution. The mill has a daily capacity of 330 tons, and it handles ore containing gold, silver, lead, and zinc.

Opinions Conflict on Possibilities of Deep Mining on the Rand

PROF. L. C. Graton, of Harvard University, who is at present staying in Johannesburg, has for some time been studying problems associated with mining at depth, such as the persistence of orebodies, rock pressures, and temperature. Professor Graton says that he has not yet formed a conclusion as to the prospects of continuing operations at greater depths than have already been reached. However, he does believe that in mines now below 5,000 ft. the type of ore deposition is such that change in the grade of ore is likely to be very slow and that mining should go as deep as physical limitations will allow, provided the cost of production does not increase too greatly. He considers the outlook for the Witwatersrand encouraging if the Rand engineers can find a means of solving the problems of ventilation and rock pressure.

Almost simultaneously with Professor Graton's rather optimistic declarations, J. E. Healey, consulting engineer of the Village Deep, the world's deepest mine, issued a somewhat dismal pronouncement in his annual report on the prospects of this remarkable enterprise. Mr. Healey makes the statement that at the great depths at which operations are being carried on (over 7,600 ft.) the danger of pressure bursts is increasing. In a number of instances the pressure has become excessive when blocks have been reduced by stoping to a certain size and these remnants have been abandoned. The area so left amounts to about 10 per cent of the original block area. It seems probable that the area at present developed will provide only a small tonnage of paying ore, leaving the eastern section—which is the only promising area—to provide the bulk of the future tonnage.

Douglas Cristopherson, retiring president of the Transvaal Chamber of Mines, remarked at the annual meeting of the Chamber that, "It is true that there are great problems yet to be solved as mining operations, especially in the central area of the Witwatersrand, approach vertical depths of 7,000 ft. or more; yet I venture to say that, with the ever-increasing strides science is making, these problems will be solved and we shall see mining at depths which were once never thought practicable."

Power Plant to Be Built at Whitewater Mines Will Permit Larger Development

ACCORDING to Arthur Lakes, consulting engineer for the Whitewater Mines, the most significant disclosure in the development done last year at the company's mine in the Slocan district of British Columbia was the proving of the west orebody down to the Nos. 13 and 14 levels. This orebody has not been developed above the No. 11 level because of the limitation of development equipment and power facilities. However, work on the construction of a hydro-electric plant will be started as soon as the snow is off the ground.

The west orebody has been opened for a length of 600 ft. on the No. 12 level, where the width along the main vein ranges from 5 to 45 ft., although only a small part of the length has been tested for width by crosscutting. Partial development of the cross orebodies shows their importance, and there is a possibility of opening up a number of these, as work progresses along the main vein in the limestone formation. Mr. Lakes, in his report at the annual meeting, emphasized the importance of the fact that for 1,700 ft. on the dip of the vein the west orebody is virgin ground. It is his opinion that this orebody alone will provide ore for the mill at its present output—125 to 150 tons per day—for fifteen to twenty years.

The mill is said to be making an excellent separation, with the lead concentrate showing little zinc, and the zinc concentrate showing little lead. At present it is operated by Petter oil engines. W. H. Burgess, general manager, expects to have the new power plant in operation before the beginning of August. Shareholders decided not to increase the capacity of the mill at present, but to use the increased power, when available, for further development of the mine.

Lucky Jim Lead & Zinc put its new mill at Zincton, B. C., into operation in the latter part of March, several months earlier than expected. It is now treating about 180 tons of ore a day. Additions are still being made to the mill and it is expected to handle 300 tons daily before the end of the year. The company is shipping between 120 and 150 tons of concentrates—chiefly zinc—to the plant of Consolidated M. & S. at Trail every week.

Duthie Mines reports that its Henderson mine, on Hudson Bay mountain, near Smithers, B. C., is in splendid physical condition and that ore production is exceeding the present capacity of the mill—60 to 75 tons a day.

Portal of the lower tunnel at the Milk Maid

M. H. Neidig and Dr. C. W. Richards visit the Milk Maid

Milk Maid Mining Company Resumes Operations

DEVELOPMENT operations have been resumed at the property of the Milk Maid Mining Company, situated in the Silver Lake district of American Fork Canyon, 30 miles south of Salt Lake City. Work is being pushed in the intermediate tunnel, and within a short time it is expected that the objective, the North Star fissure, will be reached. The lower tunnel is also being extended for drainage purposes. High-grade lead-silver ore was produced in the past from workings off an upper tunnel. The caved condition of this tunnel forced its abandonment. To develop the continuation of the orebody mined in the upper workings is the purpose of the present lower operations.

The property is at an elevation of 8,500 ft. in the Wasatch Mountains, and the accompanying photographs, which were taken on April 15, show the 3½-ft. snow that covered the section on that date. The last 12 miles of travel to the property was then being made on skis.

Officers of the company, all of whom reside in Salt Lake City, are: M. H. Neidig, president; W. T. Edwards, vice-president; H. V. Loggins, secretary; and G. Schlutz, treasurer. M. H. Neidig, W. T. Edwards, G. Schlutz, Dr. C. W. Richards, Jr., and C. W. Buckholtz form the company directorate.

Mysore Gold Mining Industry Aided by Government

MYSORE is the principal gold-producing state in India and, although production has been decreasing since 1914, it still ranks among the leading gold-producing areas of the world. Production by the five principal companies for 1927 amounted to 380,542 oz., with a value of approximately $8,000,000. In addition to gold, Mysore produces manganese, pig iron, asbestos, chrome, green quartzite, mica, and soapstone.

The Kolar gold fields, which produce nearly the entire Indian output, are situated in eastern Mysore. They were first exploited in 1864, when a shaft was sunk near Ooregum. The principal producers are Mysore Gold, Ooregum Gold, Nundydroog, Balaghat, and Champion Reefs. They obtain power from the Cauvery Falls, about 92 miles distant, where the first electric power plant was installed in 1902. These mines employ about 30,000 workers.

Development of the mining industry of Mysore would have been impossible without the aid of the state government, according to a recent report. The question of the conditions governing the granting of leases and prospecting licenses was referred some time ago to the Board of Industries and Commerce, which expressed the view that payments to the government under the profit-sharing plan were unsatisfactory and that royalties should be substituted for them, in which each payment was fixed after investigation of conditions at the mine. According to the present policy of the government, greater attention is being paid to mineral prospecting and economic investigation. The geology section of Mysore University is cooperating with the government to bring the students into closer contact with actual surveying, prospecting, and other practical work. With this object the positions of director of geology of Mysore state and professor of geology at the university have been combined. The government received 12,709 rupees from the gold companies last year for royalties.

Zinc Institute Forms Public Relations Committee

The American Zinc Institute, acting on the suggestion of President R. M. Roosevelt, has formed a public relations committee for the purpose of presenting the facts of the industry to the public and to foresee coming events. It is thought that by this means many valuable contacts can be made. Among the personnel of the committee is E. H. Robie, Associate Editor of *E. & M. J.*

Development Encouraging at Ohio Copper's Property

RESULTS of recent development in the northern portion of the Ohio Copper Company's property, situated in the Bingham mining district of Utah, are most encouraging, according to Ira B. Joralemon, geologist in charge of exploration.

The northern two-thirds of the property has been shown to be underlain by ore-bearing and highly mineralized limestones that have been the source of valuable orebodies in neighboring mines of the district. Drill holes on the property penetrating these limestones have shown large amounts of iron sulphide, and several samples have disclosed the presence of lead, silver, and gold. In the southern part of the Ohio holdings, also, a drill encountered a low-grade mineralization in one of the limestone beds that prospecting revealed just below the Mascotte tunnel.

Development of ore found by drilling 400 ft. below the Mascotte level, near the center of the property, and the development of smaller limestone bodies on the Mascotte level in the southern portion of the property, are well under way. The south crosscut has been continued to a total length of 1,700 ft., and excavation for the station and hoist room of an underground inclined shaft is well advanced. In addition, more than 344 ft. of drifting has been done in the upper, or commercial, limestone, on the Mascotte level.

It is planned to open up from the new shaft during the current year the ore found by drilling below the Mascotte level. The smaller limestone areas in the southern third of the property are being developed, and promising fissures with narrow seams of copper and lead-silver ore have already been found.

Calumet & Arizona Will Sink Shaft at Eighty-Five Mine

Calumet & Arizona Mining is to sink a new 1,500-ft. shaft at the Eighty-Five mine, at Valedon, N. M. The work will be done by the company instead of being contracted by an outside firm. The Eighty-Five mine is already operated through a three-compartment vertical shaft 1,700 ft. deep. It produces a silver-gold-copper ore.

At Bisbee, the development of the main orebody in the Campbell shaft of Calumet & Arizona is proceeding below the 1,600 level, where ore has been developed to a length of 600 ft. The mineralized zone extends from 1,400 level to the 2,200 level, and its length is estimated at 800 ft. with a width of 500 ft.

Reopen Zinc Chloride Plant

It is reported that the zinc chloride plant of the New Jersey Zinc Company (of Pennsylvania) at Palmerton, Pa., is being put in condition for the resuming of operations. It has been shut down for several years.

Shipping ore from the Whitedelf mine, Bonner County, Idaho

Whitedelf Shaft Down 240 Ft. From Main Tunnel

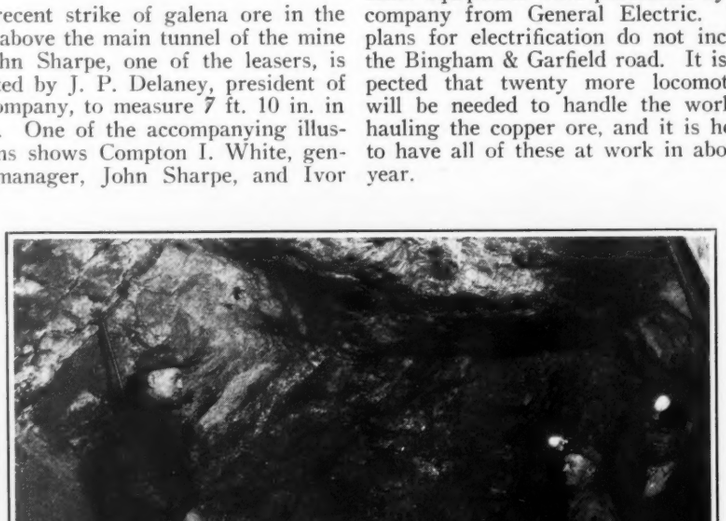
THE main shaft of Whitedelf Mining at its mine in the Clark Fork district, Bonner County, Idaho, is now down 240 ft. from the level of the main tunnel. Total vertical depth from the surface is 350 ft. Sinking of the shaft was started in January. It will probably be bottomed at 400 ft. Drifting in both directions was begun at the 200 level.

Power for exploratory and development work is now being obtained by the company from the main line of the Mountain States Power Company. A new compressor was recently installed to supplement the one that was already on the property.

The company is considering the erection of a mill, but final decision will rest on the amount of ore disclosed by the development work. According to the figures recently released by Stewart Campbell, inspector of mines for Idaho, Whitedelf Mining produced 1,852,512 lb. of lead and 108,306 oz. of silver out of a total of 2,246,284 lb. of lead and 123,906 oz. of silver produced in Bonner County.

A recent strike of galena ore in the stope above the main tunnel of the mine by John Sharpe, one of the leasers, is reported by J. P. Delaney, president of the company, to measure 7 ft. 10 in. in width. One of the accompanying illustrations shows Compton I. White, general manager, John Sharpe, and Ivor Anderson, foreman, measuring the width of the strike.

At present the ore is being shipped to the A. S. & R. smelter at Tacoma, Wash. To date 117 carloads of silver-lead ore have been shipped.



Measuring a recent ore strike at the Whitedelf

Utah Copper's Haulage Lines Are Being Electrified

All the steam haulage lines on the benches of Utah Copper's Bingham open cut mine are to be electrified, at an expense of approximately $2,000,000. Recently twenty electric locomotives and other equipment were purchased by the company from General Electric. The plans for electrification do not include the Bingham & Garfield road. It is expected that twenty more locomotives will be needed to handle the work of hauling the copper ore, and it is hoped to have all of these at work in about a year.

Midas Gold Mill Is Making Good Recovery

ACCORDING to a report by Frederick Keffer, general manager of the Midas Gold Milling & Mining Company, the mill at Libby, Mont., was turned over in the latter part of February. It is designed to handle 50 tons a day.

The ore is taken to the mill in trains of five side-dumping cars, drawn by electric locomotives. On the way it passes over scales so that the tonnage is accurately determined. The cars dump into a main ore bin, from which the ore passes to a Blake-type crusher. It is then elevated to a Symons cone crusher, which reduces it to from $\frac{5}{16}$- to $\frac{1}{2}$-in. size. The ore from this crusher falls into a mill storage bin. Before being fed to a Marcy ball mill, in which it is reduced to 50- to 60-mesh size, it passes an automatic sampler which accurately determines the contents of the heads. It then passes over amalgamated plates to remove free gold, which is about 60 to 70 per cent of the total; from 5 to 10 per cent of the silver is also amalgamated. The ore then goes to a rougher flotation machine and next to a cleaner flotation machine. Rich, silver-bearing sulphides of lead, iron, and copper are isolated, and about half of the unamalgamated gold. These sulphides are shipped direct to a smelting plant. To isolate the tungsten concentrates, which, being rich in silver and gold, need to be cyanided, the ore is passed over Deister-Overstrom tables. Contained magnetite is removed by a magnetic separator. From the tables the tailings pass an automatic sampler and then are sent to the tailings dump.

Water for the mill is pumped from a well in the creek below the mill to tanks above the building. Electric current for the pump is supplied by a d.c. generator. Power is furnished by a Fairbanks-Morse 120-hp. Diesel engine, using fuel oil. The mill is warmed by steam, a 40-hp. boiler from the old mill being used. In the mill building is a 600 cu.ft. free air capacity Chicago Pneumatic compound compressor to furnish air for the drills. A $4\frac{1}{2}$-in. air pipe line runs from mill to mine, with receiver at the mill. The compressor is driven by the Diesel engine. Storage at the mill for 10,000 gal. of fuel oil is provided and for an additional 10,000 gal. at the railway in Libby.

The composite tailings for the month of March were assayed and showed a loss of only 30c. of gold a ton. This result is very gratifying, as it is decidedly better than the results obtained in preliminary tests at Moscow, Idaho, and Los Angeles. It will not be possible to give exact figures as to results until the tungsten plant is finished.

Talc-Grinding Mill Is Being Erected at Glendon, N. C.

United Talc & Crayon is building a talc-grinding mill at Glendon, Moore County, N. C. This mill is to grind so-called talc, really pyrophyllite, from the old Phillips mine, a short distance from Glendon. The mill will be on the Norfolk Southern Railroad.

Toronto Letter

By Our Special Correspondent for Northern Ontario

McIntyre Is Now Producing Gold From the 3,375 Level —Deepest in Canada

TORONTO, MAY 5, 1928.—McIntyre Porcupine Mines, in the Porcupine district, is now producing gold from the 3,375 level, the greatest depth from which gold ore has been produced in Canada. The drift is in ore and has been for 50 ft., but it is too early to make an estimate of average grade. This is the first ore in the new shaft below the lowest level of the old shaft. At 3,875 ft., the deepest level attained by the new shaft, a crosscut is within a comparatively short distance of the nearest vein system, and some announcement may be expected in the near future. It is expected that the company will make definite plans regarding mill expansion after these two levels, the 3,375 and 3,875, have been opened up to some extent. This will probably involve the building of a new mill near the headframe of the new shaft. At present, ore from this shaft, which is known as No. 11, is trammed on the surface to the old shaft and then transported across the lake by aërial tramway.

DEVELOPMENTS on the 400 and 500 levels at the Noranda mine, in the Rouyn district, Quebec, have cut the "C" and "E" orebodies, two of the largest on the property. It is understood that the grade of the "E" orebody is better than at 300 ft. Production is now at the rate of 1,000 tons of mine ore a day, but there has been some drop in grade. Good progress is being made in constructing the concentrating plant, which will be used to treat ore of less than 5 per cent copper. In July, Waite-Montgomery will start shipments of selected high-grade copper ore direct to the smelter.

At the annual meeting of the Aldermac property, situated in the Rouyn district, it was stated that ore reserves are now more than 1,250,000 tons containing copper, zinc, and small amounts of the precious metals. The shaft, which is down to 750 ft., will be continued to 1,250 ft. before more lateral development work is done. Mill plans will not be definitely decided upon for another six months, but when built the mill will have a capacity of not less than 1,000 tons a day. Aldermac is controlled by Noranda.

Preparations are being made to sink the north shaft of the Wright-Hargreaves mine, in Kirkland Lake, from 1,750 to 2,000 ft. The south shaft will also be sunk to the same depth and a connection between the two shafts at the bottom level made. Loading pockets have been completed on the 1,750 level, where ore has been opened on the north vein. This ore is said to be of a higher average grade than the rest of the mine and should have a beneficial effect on mill heads, which have recently been averaging about $7. It was announced at the annual meeting that $9 heads might be expected in the near future. The mill is now treating 750 tons a day.

Mining Corporation of Canada has decided to stop work on its Cross Lake shaft and has given formal notification that the options on the property will not be exercised. The shaft has reached a depth of 400 ft., and a number of veins were encountered in drifting and crosscutting, but none of them showed ore of commercial grade. On the adjoining property, the O'Brien mine has encountered some high-grade ore, but values are said to be erratic.

100-Ton Mill Is Being Built at Balatoc, P. I.

BENGUET Consolidated Mining, in the Philippine Islands, is milling about 5,000 tons of ore per month and producing $85,000 in bullion per month. Ore reserves have been substantially increased, although grades are somewhat less.

A 60 per cent interest has been acquired in the Balatoc property, close by, under an agreement that obligates Benguet to spend up to $300,000 on the new property. Discoveries of high-grade gold ore were made and exploration and development have been consistently pushed. A 100-ton mill is now being erected on the Balatoc and the company officials expect it to be in operation in September. Ralph Crosby is in charge of the new installation.

Benguet is also constructing a new hydro-electric power plant of 1,000-kw. capacity. The company has already two high-head electric power plants aggregating 650 kw. and a Diesel plant of 480 hp.

The new power plant is being constructed by a subsidiary company, Luzon Power. General Electric generators and Pelton low-head turbines, operating under 97-ft. maximum head, have been purchased as well as steel towers for transmission line and accessories, all of which have been shipped from San Francisco. The plant is 8 miles from the mines. Several unique features are involved, one being an underground installation of turbines and generators. This will involve sealing the whole structure against back water. Heavy road construction has been necessary. The transmission line will carry 23,000-volt current.

North Carolina Gold Mine Is Being Unwatered

The Coggins gold mine, owned by Rich-Cog Mining, 12 miles northwest of Troy, Montgomery County, N. C., is being unwatered. The mine shaft is more than 500 ft. deep. It has never been extensively worked. There is a small amalgamation mill on the property.

London Letter

BY W. A. DOMAN
Special Correspondent

Horo Concession in Swaziland Will Be Opened to Prospectors

LONDON, APRIL 24, 1928.—It is announced from South Africa that the Horo Concession, in Swaziland, is to be opened to prospectors. It is the largest mineral monopoly in Swaziland, situated partly on the Transvaal border, and including Piggs Peak, where gold mines have been worked in the past. Most of the creeks, it is reported, show traces of gold in the gravels. Encouraging developments which have recently occurred in the country, in both the stanniferous and auriferous zones, have changed the policy of the concessionaires, who have delayed opening up the areas till now. It is said that Mr. Amery, the Colonial Secretary, desired to have the deposits tested.

DIRECTORS of Tanganyika Goldfields have succeeded in obtaining the co-operation of Belgian capital for the development of their concession, which covers about 1,000 square miles in Tanganyika and Uganda. The company has interests in Kagera, Ankole, and Bukoba tin fields and the Ruandi-Urundi concession.

Gold Fields Rhodesian Development has entered into a revised agreement with Rhodesian Exploration and other companies, to purchase the Wanderer mine, in Rhodesia, a low-grade property which has not been worked for some time, but which has been re-examined. A company has been formed with a capital of £600,000, of which £137,000 will be working capital and 140,000 shares will be held in reserve. Two other areas in the vicinity are being tested and there is the possibility that a big development scheme may result.

United Verde Establishes Microscopic Laboratory

Owing to the increasing importance of microscopic examinations of ore in milling practice, United Verde Mining is establishing a microscopic laboratory at Clarkdale, Ariz. This action follows a recent visit by Oral E. Young, of United Verde, to the Intermountain Station of the U. S. Bureau of Mines at Salt Lake City, where he investigated with R. E. Head, microscopist of the station, the utilization of the microscope in ore dressing.

Mr. Head left Salt Lake City on May 5 to spend a month at the new laboratory. He will confer with O. C. Ralston, consulting metallurgist of the company, and will supervise the establishment of the laboratory on a working basis.

Societies, Addresses, Reports

Program Announced for World Engineering Congress

WITH the opening date of the first World Engineering Congress set as Oct. 30, 1929, at Tokio, Maurice Holland, executive secretary of the American committee arranging for engineers of this country to participate, recently made public the program of the event as outlined by the Japanese authorities. Mr. Holland said that the World Congress would extend through the month of November, the official languages being English and Japanese. The first week of the meeting is to be devoted to technical papers and social meetings and the second week to inspection trips in Tokio and the vicinity. The next fortnight will be set apart for trips throughout Japan, arranged to give engineers attending the Congress an opportunity to visit the great industrial centers of the country and to study Japanese engineering problems.

The World Engineering Congress aims to deal with many of the world's vital problems, Mr. Holland said, particularly those relating to public works, communication, and transportation, power, chemicals, textiles, and aeronautical and automotive engineering. Almost every activity of daily life as touched upon by modern science and invention will be reflected in the deliberations of the Congress.

"It is reasonable to expect," Mr. Holland said, "that public problems of great moment will be illuminated and a way to their solution pointed by interchange of ideas at this gathering, in which will be represented the foremost engineering authorities and scientists in the world."

Hoover's Work in Burma Related by Dr. Mathewson

HERBERT HOOVER'S connection with the famous Bawdwin lead-silver-zinc mine in upper Burma was related recently by Dr. E. P. Mathewson, president of the A.I.M.E. in 1923, and professor of mining administration at the University of Arizona, according to the New York *Times*. The property, situated several hundred miles northeast of Mandalay, was visited by Dr. Mathewson in a professional capacity in 1922, so that he is familiar with the history of the mine. The following excerpts are from Dr. Mathewson's remarks:

"During the early years of Mr. Hoover's professional career, he took over the general management of the Bawdwin mines. So far as I know he did not make a personal visit to the mines. His connection with them was through Bewick, Moreing & Company, of London, which financed and managed the property. His brother, Professor Theodore Jesse Hoover, however, was sent out to the Bawdwin and spent some time there as mining engineer.

"When the World War broke out Herbert Hoover severed his connections with the London company and, indeed, disposed of all his mining properties, to devote himself to Belgian relief work.

E. P. MATHEWSON

"The Bawdwin was very rich in mineral, there being hardly any waste or gangue. It assays 26 per cent lead, 18 to 20 per cent zinc, and 23 oz. of silver to the ton. The balance is chiefly a little copper and a large amount of sulphide of iron, or pyrite.

"The Chinese smelted the ore in crude furnaces, operated with charcoal and blast, which at the same time exactly met the metallurgical conditions. The Chinese were metallurgists. They did not want the lead or zinc in the ore, since either of these minerals would have been too heavy to transport over the mountains. The silver was the only thing of value for them—and they got it pure, without having to take with it other metals.

"Mr. Hoover was among the first to realize the opportunity for development that lay in the Bawdwin mines, and events have justified his faith. In fact, it was American enterprise that contributed largely to the success of the property."

University of Utah Announces New Fellowships

INVITATION is extended to qualified men to make application for fellowships in the department of mining and metallurgical research, University of Utah, during the year 1928-29. This department is maintained in connection with the Intermountain Experiment Station of the U. S. Bureau of Mines, and is a department of co-operative research maintained by these two organizations. Fellows work under the supervision of experts in this department. Recent appropriations of the Utah Legislature permit of a considerable expansion of the department this year.

Problems to be investigated in the course of the year 1928-29 are:

1. Flotation. Fundamentals on flotation of pure minerals and gangue constituents.
   (a) Physical-chemical investigations.
   (b) Experimental investigations.
2. Hydrometallurgy of zinc. Study of losses in present hydrometallurgical practice and of their prevention where not due to mechanical causes.
3. Hydrometallurgy of lead. Purification of lead leach liquors.
4. Pyrometallurgy of complex lead-zinc ores.
5. Differential sulphating of complex ores and concentrates to facilitate subsequent separation by milling or leaching.
6. Pyrometallurgy of lead. A study of the forms in which lead is lost in lead blast furnace slags and of methods for prevention of these losses.

Several fellowships are to be awarded, each having an annual net value of $720. These fellowships are open to college graduates who have had a good training in chemistry and metallurgy. Applicants should send a copy of their records from the registrar's office of the college where they have, or will be, graduated, and the names and addresses of at least three references who know their character, ability, and attainments.

Holders of these fellowships will be subject to the rules governing employees of the U. S. Bureau of Mines and will report for duty about July 1, 1928. They must also register as students in the University of Utah and become candidates for the degree of master of science (unless this or an equivalent degree has been previously earned). Their time will be devoted to classroom, library, and laboratory work. Fellows are appointed for one year, but the appointment may be renewed.

Foundry Research at Mellon Institute

ANNOUNCEMENT has been made by Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research, Pittsburgh, Pa., that the Whiting Corporation, Harvey, Ill., has established in the institution an industrial fellowship, the holder of which, Dr. Edward E. Marbaker, will conduct research on cast iron. The results of these investigations will be published for the general benefit of the foundry industry.

For a number of years the Whiting Corporation has been carrying on a systematic program of development for the purpose of improving equipment and methods for the production of cast iron. It has recently been determined to expand this work, and in consequence the corporation will sustain research at Mellon Institute. Dr. Marbaker, the Whiting Corporation Fellow, will work in close co-operation with the research committee of the American Foundrymen's Association.

Lead Poisoning and Dust and Pulmonary Diseases Discussed by Chemical Section of the National Safety Council

AT THE mid-year meeting of the chemical section of the National Safety Council, in Newark, N. J., on April 26, considerable attention was devoted to two subjects of particular interest to the mining industry. Dr. Frederick L. Hoffman, of the Babson Institute, Wellesley Hills, Mass., spoke on "Lead Poisoning," and Dr. A. E. Russell, assistant surgeon, U. S. Public Health Service, Washington, D. C., was the principal speaker on the subject of "Dust and Pulmonary Disease."

According to Dr. Hoffman, the results of his statistical studies indicate that fatal lead poisoning is a declining factor in the vital statistics of the nation. However, lead absorption is becoming increasingly prevalent in industry. The point at which lead absorption becomes lead poisoning is not definitely established, and research on this phase of the subject is needed. Medical staff members of the Metropolitan Life Insurance Company and representatives of E. I. du Pont de Nemours & Company contributed to the discussion on the subject. Both of these were of the opinion that vital statistics, as revealed from death-certificate studies, might be misleading, because of the unfamiliarity of many reputable physicians with the various forms of lead poisoning. The larger proportion of lead-poisoning fatalities occurs to members of the painters' trade. Lead absorption is common among workers in the storage-battery industry, although cases of fatal lead poisoning are rare. Lead smelters were mentioned as very great hazards, wherein the need for the utmost care and precautionary action was realized. Some instances of lead poisoning, particularly in the State of Maine, were reported from non-industrial sources, such as drinking water conducted through lead pipe; also, instances of lead poisoning in infants and young children as a result of the use of painted articles on which to assist teeth-cutting are not unknown.

Injurious Element in Dust Is Free Silica

On the subject of "Dust and Pulmonary Disease," Dr. Russell stated that the studies of the U. S. Public Health Service have indicated that the injurious element in all dust is free silica or quartz, whereas mineral silicates and other chemical products, regardless of their hardness, do not have the injurious effect that has been attributed to them. The dust is cumulative in the system and results in the contraction of silicosis, which brings on a tubercular condition that, in its advanced stages, is usually fatal. Tubercular silicosis varies from the usual forms of tuberculosis in that early symptoms, during the silica-accumulation period, are practically negligible, but when it does take hold it is more virulent, and the end comes quickly. Several of those present expressed an opinion, that the sharpness or abrasive action of the dust particles might be an important agent in the development of tubercular silicosis, but Dr. Russell contended that the result of his studies had indicated the harmful effects to be the result of a chemical reaction resulting in the formation of a colloidal silica, a virulent poison, tending to destroy the lung tissue. The silica entering the lungs has been microscopically examined, and in no case were the particles larger than 10 microns in diameter, at which size the sharpness of the faces is not a controlling factor. Lime dust, unless contaminated with free silica, is not harmful, but is of benefit, as the lime is absorbed and utilized in the body. Anthracosis, the term applied to pulmonary disease contracted by miners in the anthracite mines, is ordinary silicosis, according to Dr. Russell, and only free silica, which is present to some extent in the dust of all coal mines, causes the trouble. Men working in the dusty trades should have opportunity for regular vacations, or lay-offs, as the physical condition of the individual is the most important factor in combating silicosis, regardless of the fact that silica in the lungs is cumulative in its effects.

Salt Lake Operators Advise on Research Work

Group of Special Committees Meets Periodically With Technicians of University of Utah and U. S. Bureau of Mines

By H. D. Keiser
Assistant Editor, Salt Lake City

FURTHER PROGRESS in the general plan for greater co-operative effort between the mining industry and the department of mining and metallurgical research of Utah University, together with the Intermountain Station of the U. S. Bureau of Mines, is reflected by the recent appointment of a group of special advisory committees composed of leading operating technicians in the mining industry of the Utah district. These committees will meet periodically throughout the year with the staff of the department and that of the station to advise concerning the research work in progress and the adaptation of this work to the needs of the mining industry.

Members of the advisory committees were designated by the advisory board to the department and station, which board includes in its membership the following prominent executives of mining and smelting companies of the district: L. S. Cates, chairman, vice-president and general manager of Utah Copper; J. O. Elton, manager, International Smelting; G. W. Lambourne, president and manager, Park Utah Consolidated Mines; E. J. Raddatz, president and general manager, Tintic Standard Mining; W. J. O'Connor, manager, Utah department, American Smelting & Refining; W. H. Eardley, assistant manager, U. S. Smelting, Refining & Mining; and W. Mont Ferry, managing director, Silver King Coalition. Dorsey A. Lyon, director of the department of mining and metallurgical research of the University of Utah and supervising engineer of the Intermountain Station of the U. S. Bureau of Mines, serves as secretary of the Advisory Board.

The several fields covered by the special advisory committees and the personnel of these committees follow:

1. *Microscopic Examination of Ores*
   H. S. Martin, chairman, Utah Copper; Alan Probert, U. S. Smelting, Refining & Mining; W. J. McKenna, International Smelting; T. A. Janney, Arthur Plant, Utah Copper.
2. *Grinding*
   C. A. Lemke, chairman, U. S. Smelting, Refining & Mining; W. J. McKenna, International Smelting; Roy Hatch, Utah Copper; W. E. Englemann, Utah Copper.
3. *Flotation*
   R. A. Pallanch, chairman, U. S. Smelting, Refining & Mining; H. B. Wilson, International Smelting; T. A. Janney, Utah Copper; H. S. Martin, Utah Copper; C. G. Williams, Utah Copper; M. G. Heitzman, Silver King Coalition Mines.
4. *Smelting*
   B. L. Sackett, chairman, International Smelting; Robert Wallace, U. S. Smelting, Refining & Mining; J. F. Austin, American Smelting & Refining.
5. *Health and Safety*
   J. G. Hadley, chairman, Utah Copper; Dr. H. A. Hosmer, U. S. Smelting, Refining & Mining; J. C. Welch, International Smelting; H. H. Romney, American Smelting & Refining.
6. *Leaching*
   This committee will be appointed soon.

Four Research Fellowships Offered by University of Alabama

FOUR fellowships in mining and metallurgical research have been offered by the school of mines of the college of engineering of the University of Alabama in co-operation with the U. S. Bureau of Mines. The fellowships are open to graduates of universities and engineering schools who have the proper qualifications to undertake research investigation. The value of each fellowship is $675 per year of nine months beginning Sept. 1.

Applicants should send a copy of their collegiate records from the registrar's office of the institution where they have graduated. They should also state their professional experiences and give the names and addresses of at least three persons who are familiar with the training and ability of the applicant. Letters of recommendation will be welcomed. Applications should be addressed to the Director of the School of Mines, University of Alabama at University, Ala., and should be received not later than June 1, 1928.

Personal Notes

A. HENRI SINN, of Paris, is in Morocco examining a tin prospect.

H. H. KNOX is in New York on his way from London to Australia.

DURAND A. HALL has returned to Berkeley, Calif., from an examination of mines in Sonora, Mexico.

H. I. SHATTUCK has been elected mining-bureau representative of the Denver Chamber of Commerce.

HIRAM W. HIXON is returning to the United States from Europe after an absence of four and a half years.

FRANK M. SMITH, of Spokane, Wash., director of the Bunker Hill smelter at Kellogg, Idaho, was recently in San Francisco.

J. G. Ross, consulting engineer of Montreal, is making an examination of the property of the Clericy Centre Mines, Ltd., in the Rouyn area.

HOMER K. SHERRY, mine superintendent at the Asbestos, Que., properties of the Canadian Johns-Manville Company, was a recent visitor in Salt Lake City.

L. HIRSHLER, of New York, consulting engineer for S. A. de la Vieille-Montagne, has been elected a director of the Belgian Chamber of Commerce in the United States.

R. E. CRANSTON, general manager of the South American Gold & Platinum Company, has returned to New York after a trip of inspection through the Choco district of Colombia.

GEORGE H. GARREY, who recently spent three weeks at the Piermont and Ruby Hill Apex properties near Ely, Nev., is now at the Alto mine, in the Patagonia district of Arizona.

R. W. STRAUS, vice-president of American Smelting & Refining, has returned to his New York City headquarters, following a visit to the Salt Lake City offices of the company on May 2-4.

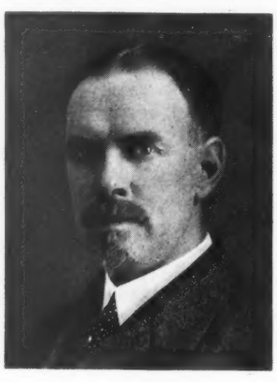
G. R. INGHAM read a paper on "Operations of the New Cornelia" at a recent meeting of the Arizona chapter of the American Mining Congress at Ajo, Ariz. I. GRAGEROFF and W. L. DUMOULIN also presented papers.

A. W. ROGERS, chairman of Rand Mines, Ltd., was recently elected president of the Transvaal Chamber of Mines. P. M. ANDERSON and ARTHUR FRENCH were at the same meeting elected vice-presidents.

D. D. MUIR, JR., manager of U. S. Smelting, Refining & Mining, on April 27 addressed the mining committee of the Salt Lake Chamber of Commerce on the importance of the company's operations to the State of Utah.

FLOYD S. WEIMER has returned to Paris after a trip through Italy, Poland, and Norway. Mr. Weimer is acting as consulting engineer for electrolytic zinc plants and inspected plants under construction in these countries.

DR. FRANCIS ANDREW THOMSON, since 1917 dean of the Idaho school of mines, a division of the University of Idaho at Moscow, has accepted the presidency of the Montana School of Mines at Butte, succeeding GEORGE W. CRAVEN, whose resignation is effective June 30, this year. Dean Thomson will remain at Idaho until the close of the college year, but will transfer to Montana immediately after. His resignation covers not only the directorship of the university school of mines but the executive secretaryship of the Idaho bureau of mines and geology, a state



F. A. THOMSON

field service which has figured prominently in advancement of the mineral resources of the state. Dean Thomson organized the bureau and developed it to the point where it receives an annual state appropriation of $80,000. Dr. Thomson is a graduate of the Colorado School of Mines. He received his master's degree from that institution in 1914. In 1923 his alma mater took cognizance of his progress in the industry by awarding him an honorary degree of doctor of science. It was the third honorary doctorate to be conferred by the Colorado institution. Dr. Thomson's early education was received in Barking Academy, Essex, England; public high school, Victoria, B. C.; and Columbia College, New Westminster, B. C. From 1896 to 1898 he was assayer of the Victoria Metallurgical Works; 1901 to 1902, construction engineer on the copper smelter for the Northwest Smelting & Refining, Croston, B. C.; 1903, chief designing draftsman for the Albion Iron Works at Victoria; 1904 to 1908, superintendent and consulting mining engineer and superintendent of mines in Colorado and Goldfield, Nev.; 1908 to 1917, professor of mining engineering at Washington State College. Under Dean Thomson's administration the Idaho School of Mines has enjoyed a steady growth and its present enrollment includes students from all leading mining states of the country.

CHARLES E. STEARNS has resigned his position as general superintendent of the Whiterock Quarries, Bellefontaine, Pa., and is now connected with the Certain-teed Products Corporation at its Niagara Falls, N. Y., plant.

E. W. PEHRSON has resigned his position as miscellaneous valuation engineer with the Bureau of Internal Revenue at Washington, D. C., and has accepted the position of mineral economist with the Bureau of Mines.

WILLIAM SIXT, formerly superintendent of Kirkland Lake Gold, has been appointed manager of the property. J. B. TYRELL retains the office of vice-president and managing director, but he has given up the active direction of mining operations.

OLIVER BOWLES, recently transferred from the New Brunswick station of the U. S. Bureau of Mines to the Economics Branch of the Bureau as chief of the building-materials section, is now located in Washington, D. C., and should be addressed there, care of the Department of Commerce.

TYSON S. DINES, of Denver, Colo., and R. L. CHASE, mining engineer of Los Angeles, have started operations at the Barrance del Cobre property near Chihuahua City, State of Chihuahua, Mexico. The property is now operating under the name of Cia. Explotadora de Chihuahua, S. A., with W. M. MATHEWS in charge.

DEAN DEXTER S. KIMBALL, of Cornell University, has accepted the consulting editorship of the new "McGraw-Hill Industrial Management Series." The first volume in the series will be "Standards and Standardization" by N. F. HARRIMAN, senior engineer-physicist, National Bureau of Standards; vice-chairman, Federal Specifications Board; member of the Federal Purchasing Board and Bureau of the Budget, U. S. Government, and will be published during the summer. This series is logically arranged to cover the whole field. The manuscripts of several of the volumes are in process and will appear as they are completed.

OBITUARY

FRANKLIN BALLOU, mining engineer, killed himself in New York City on May 3. Mr. Ballou was a graduate of the Sheffield Scientific School in 1901.

CHARLES LOUGHRIDGE died at his home in Denver, Colo., on April 27. Mr. Loughridge was president of the Pennsylvania Mines Company, which owns property in Ouray County, Colo. He was 70 years old.

ALMON E. CULBERTSON died May 3 in New York City. Mr. Culbertson was a geologist and mining engineer who lived for the greater part of his life in Russia. He received his degree in mining engineering from the Imperial Institute.

Market and Financial News

Anaconda's Net Income for 1927 Reduced by $4,100,000

New Installations a Feature of Company Report—Subsidiary Properties Preparing for Cost Reductions Through Increased Metallurgical Efficiency

LOW METAL PRICES were responsible for the decline in Anaconda's net income for 1927, as they were for a similar decline in 1926. Net income for 1927 is $7,417,274 less than in 1925, the record year.

John D. Ryan, chairman of the board of directors, says in the report:

"The *Engineering and Mining Journal* reports the following average prices: Copper, 12.92c.; lead, 6.755c.; zinc at St. Louis, 6.242c.; silver, 56.370c.—a decrease from the prior year's average quotations of copper, 13.795c.; lead, 8.417c.; zinc, 7.337c., and silver, 62.107c. The recession in the volume of domestic business was not met by producers with a curtailment of production adequate to meet the situation, until stocks had accumulated to a large total and prices had declined to a very low level. During the last half of the year copper production was somewhat curtailed, and the price of the metal made an advance of about 1.5c. per pound. The export business during the year showed a satisfactory increase in volume, the total shipped from North and South America being 641,865 tons, compared with 525,861 tons for the previous year. The decrease in the income of your company from that of the previous year was due to its curtailed operations and the low prices received for its products."

Operations of the company and its subsidiary and affiliated companies were generally continuous throughout the year, but production was slightly curtailed as indicated in the foregoing statement by Mr. Ryan. During the year the Detroit Copper & Brass Rolling Mill Company, with established plants and business at Detroit, Mich., was purchased at a price of $12,600,000. This purchase was financed in part by short-term notes appearing on the balance sheet as "Notes payable." Manufactured production of the American Brass Company was less than the high record established in 1926, but was at a satisfactory rate, distributed among the various plants as follows:

	Pounds
Ansonia	152,349,539
Buffalo	78,694,940
Detroit	28,931,978
Hastings	96,415,118
Kenosha	117,399,303
Torrington	61,515,019
Waterbury	89,603,528
Toronto	18,001,753
Total	642,911,178

Particularly gratifying growth was noted in the output of the company's Anaconda Brass Pipe and its special patented alloys—Anaconda Phosphor Bronze, Tobin Bronze Welding Rods, Ambrac Metal and Everdur, a manganese-silicon bronze having the strength of steel and which resists rust.

The various mining properties owned by the company produced the following tonnages during the year:

	Copper Ores	Zinc Ores	Lead-Zinc Ores	Phosphate Rock
Butte mines	2,910,520	13,235	.....	.....
Anselmo	45,483	3,284	.....	.....
Utah-Delaware	1,856	.....	148,991	.....
Utah-Delaware leases	30,233	.....	17,872	.....
Conda	.....	.....	.....	18,087
Conda leases	.....	.....	.....	27,264

Drifts, crosscuts, raises, winzes, and shafts in the development work of the company at its Butte mines were extended 30.67 miles in 1927, compared with 34.41 miles during 1926, a decrease of 10.87 per cent.

Production of zinc ore was limited to the amount necessarily extracted in the course of the development work, because of the low price which prevailed for zinc throughout the year and the available tonnage of custom concentrates.

Construction at Anaconda of a new electrolytic zinc plant of 150 tons' daily capacity was begun in 1927 and was completed. Production therefrom began in February, 1928.

Work of remodeling the Anaconda concentrator to treat ore by selective flotation was completed in August, materially increasing the grade of concentrates and reducing smelting costs. A central crushing plant was completed during December, feeding two sections by the end of the year, and will be extended to other sections in 1928. Production, including purchased and toll material, was as follows:

	Copper, Pounds	Lead, Pounds	Silver, Ounces	Gold, Ounces
Anaconda	221,300,270	.....	6,638,126	32,674
Tooele	20,119,391	146,073,315	8,001,707	56,849
Miami	125,415,476	.....	344,699	9,003

The Anaconda Reduction Works treated, for all companies, the following tonnages:

	Concentrators	Smelters	
	Ore	Cuprous Material	Lead Material
Anaconda Copper concentrator	2,866,785	.....	.....
Anaconda zinc concentrator	480,165	.....	.....
Tooele concentrator	395,683	.....	.....
Rico concentrator	58,942	.....	.....
Anaconda smelter	.....	906,534	.....
Tooele smelter	.....	116,909	288,300
Miami smelter	.....	237,810	.....

During the year a contract with the American Smelting & Refining Company was entered into for the treatment of waste slag from the blast furnaces at that company's plants in Montana and Utah, to recover zinc contained in the slag. An experimental plant consisting of a coal-dust-fired water-jacketed furnace, brick flue, steel cooling flue, fans and baghouse was built on the slag dump of the East Helena plant and put into operation at the end of the year. This plant will recover the zinc as a fume, and the recovered material will be sent to the electrolytic zinc plant at Great Falls for final treatment.

Concerning companies controlled but not wholly owned, it is stated that development work in the North Lily mine, at Eureka, Utah, was continued during the year with encouraging results. Further shaft sinking and development work will be continued, together with surface improvements consisting of change house, warehouse, hoists, and compressor, with ore bins and aërial tramways to connect with the D. & R. G.-W. Railway. In the course of development 21,486 tons of ore, assaying 25.5 per cent lead, 16.2 oz. silver, and 0.11 oz. gold, was extracted. The improvements, should now be completed and the mine be ready for production.

Comparative Financial Statements of Anaconda Copper Mining Company

	1927	1926	1925	1924
Gross income	$246,682,861	$272,845,362	$263,415,956	$213,113,500
Operating expenses and taxes, etc.	225,394,901	250,354,372	236,861,718	197,060,811
Operating profit	$21,287,960	$22,490,990	$26,554,238	$16,052,689
Other income	6,981,394	6,880,926	6,552,991	5,692,276
Total income	$28,269,354	$29,371,916	$33,077,229	$21,744,965
Depreciation and obsolescence	4,765,672	4,885,598	5,049,348	4,231,422
Interest, discount on bonds, etc.	13,382,541	10,255,100	10,482,519	10,806,001
Apportioned to minority interests	(a) 2,117	5,016	4,830	(a) 11,673
Net income	$10,123,258	$14,226,202	$17,540,532	$6,719,215
Dividends	9,000,000	9,000,000	9,000,000	2,250,000

(a) Loss.

Anaconda's Construction Expenditures During 1927

Butte mines—Mainly on completion of installations of electric hoists at the Badger State, Mountain Con, and Belmont mines	$1,239,367
Reduction Works, Anaconda—Construction of new electrolytic zinc plant and remodeling of copper concentrator and crushing plant	3,576,980
Reduction works, Great Falls—Installation of secondary purification plant at electrolytic zinc plant and miscellaneous construction	385,164
Slag-treating plant, East Helena—Construction of plant for treatment of East Helena slag	474,304
The American Brass Company—Improvements to buildings and machinery	774,030
Raritan Copper Works—Mainly on power plant improvements	442,173
International Smelting Company—Mainly on mill improvements and Cottrell treater at Tooele plant	205,405
Miscellaneous construction items	241,962

Chile Copper Company reported net income of $11,085,537 in 1927, charging $7,777,054 against income for taxes, interest and discount on bonds, depreciation and obsolescence of plant and equipment, and miscellaneous charges. A total of 219,600,465 lb. of copper was produced at an average cost of 8.737c. a pound. Expenditures on construction work totaling $5,110,274 were made. Because of the unfavorable market conditions existing throughout the year, the company did not utilize its increased productive capacity. A total of 7,711,952 short tons of ore was crushed during the year. The average leaching extraction obtained from the treatment of 709 charges was 88.85 per cent, compared with 88.83 per cent for 1926. During the year 219,600,465 lb. of electrolytic copper was produced. The following tabulation shows a comparison of results by quarters:

Period	Ore Crushed, Short Tons	Average Per Day	Per Cent Copper in Ore Leached	Per Cent Ampere Efficiency	Per Cent Net Recovery	Pounds Copper Produced
First quarter	2,329,927	29,493	1.512	83.33	86.78	56,275,993
Second quarter	1,969,287	25,575	1.628	81.49	87.51	55,278,560
Third quarter	1,724,893	23,957	1.642	87.16	91.07	53,949,028
Fourth quarter	1,687,846	24,821	1.622	86.42	91.14	54,096,884
Year	7,711,952	26,054	1.595	84.40	89.05	219,600,465

The average number of inhabitants in Chuquicamata during 1927 was 15,855, compared with 18,039 for the year 1926. At Tocopilla the average number of inhabitants housed by the company during the year was 638, compared with 641 for 1926. The average working force at Chuquicamata for the year was 5,594 men, of whom 5,059 were on operation and 535 on construction. At Tocopilla the average working force for 1927 was 613 men, of whom 478 were on operation and 135 on construction.

Operations at the Walker mine, in California, were continuous throughout the entire year of 1927. The concentrator treated 340,156 tons of ore assaying 1.49 per cent copper, from which 19,268 tons of concentrate, assaying 24.4 per cent copper, was produced.

A dividend of 7 per cent was paid on the preferred stock of the Silesian-American Corporation during the year. The properties of its subsidiary, Giesche Spolka Akcyjna, Katowice, Poland, operated satisfactorily throughout 1927. The company produced approximately 123,800,000 lb. of zinc and 10,800,000 lb. of lead during the year.

At the Andes Copper Mining Company, Potrerillos, Chile, work on the new metallurgical plant for the treatment of oxidized ores was continued, and the plant should be in operation some time in May, 1928. From the sulphide ores of this company there was produced 54,377,048 lb. of copper, 133,621 oz. silver, and 7,125 oz. gold. Expenditures made during the year on mine development, metallurgical plant, railway, and miscellaneous equipment amounted to $10,028,798. The company reported net income of $179,950 after allowing $250,000 for depreciation. The future of the enterprise, according to John D. Ryan, chairman of the board of directors, is outlined in the following statement: "Considering the magnitude of this enterprise and that this was the first year of its operation in part, the results are very satisfactory, and have demonstrated not only the importance and value of the property as a great low-cost copper producer with an ability to earn substantial returns at any probable price for copper when conditions permit its being fully operated, but also that the estimates as to the productive capacity of the plants were conservative and that an output of 225,000,000 lb. of copper per annum can be made."

Refinery Production of Anaconda for 1927

	Gold, Ounces	Silver, Ounces	Copper, Ounces	Lead, Pounds	Zinc, Pounds
Great Falls copper refinery	.....	.....	(a) 245,402,154	.....	.....
Raritan copper works	147,438	18,896,528	378,099,665	.....	.....
Great Falls electrolytic zinc plant	7,308	3,008,126	2,037,910	20,438,939	(b) 237,536,851
International lead refinery	32,821	7,433,720	.....	(c) 168,532,840	.....

(a) Cathodes; (b) Includes 12,403,407 lb. of zinc in dross; (c) includes 6,519,910 lb. of antimonial lead.

COLORADO FUEL & IRON COMPANY reports net income of $2,577,518 in 1927, compared with net income of $2,748,414 in 1926. Dividends on preferred stock amounting to $160,000 were paid in 1927, as in 1926.

CALLAHAN ZINC-LEAD COMPANY, operating in the Coeur d'Alene district, Idaho, reports income of $70,179 in 1927, before depreciation and depletion, which compares with the deficit of $95,345 reported in 1926. The Galena mine was operated continuously throughout the year and produced 54,698 tons of ore, assaying 5.55 per cent lead and 4.18 oz. silver. The flotation mill was operated at a capacity of 150 tons per day, with an operating crew of five men.

NEWMONT MINING CORPORATION, a New York holding company interested in many of the large mining producers, reports gross profits of $16,791,516 for 1927. Of this total $1,435,896 was paid out in dividends and $14,493,450 was carried to earned surplus account. During the year the company took options on and made examinations of properties in California, Nevada, Utah, Mexico, and Newfoundland, but none of these options was exercised. It has been interested with others in options on properties in South Africa and South America, on which development work is being done. It also acquired, during the latter part of the year, an interest in the Flin Flon property, in the Province of Manitoba, Canada.

International Zinc Cartel

LEADING zinc producers of the world met at Brussels, Belgium, on May 7, to consider the formation of an International Zinc Cartel. Officials representing the leading zinc producing countries of Europe were present. C. F. Kelley, president of Anaconda Copper, and Ludwig Vogelstein, chairman of the board of directors of American Metal, who happen to be in Europe, are reported to have attended the meeting, informally. As the United States controls about 45 per cent of the world zinc production, American participation is eagerly sought. A committee was appointed to work out ways and means of securing American co-operation.

STATISTICAL NOTES

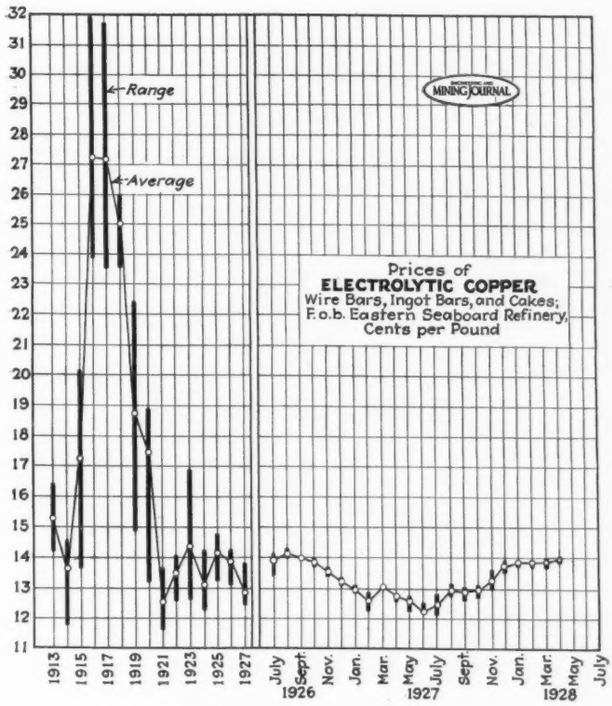
SHATTUCK DENN MINING CORPORATION suffered a net loss of $116,955 in 1927, after allowing for depletion and depreciation. The lead concentrator of this company was closed down on June 1, and, subsequent to July 1, about 100 tons of lead ore per day was shipped to the new concentrator of the Phelps Dodge Corporation at Bisbee. The total tonnage extracted at the Shattuck mine was 62,841 wet tons, a decrease of 18,392 tons from the 1926 figure. This decrease was due to the reduction in tonnage of lead mill-ore. Net operating costs were 11.835c. per pound of copper produced and 7.731c. per pound of lead.

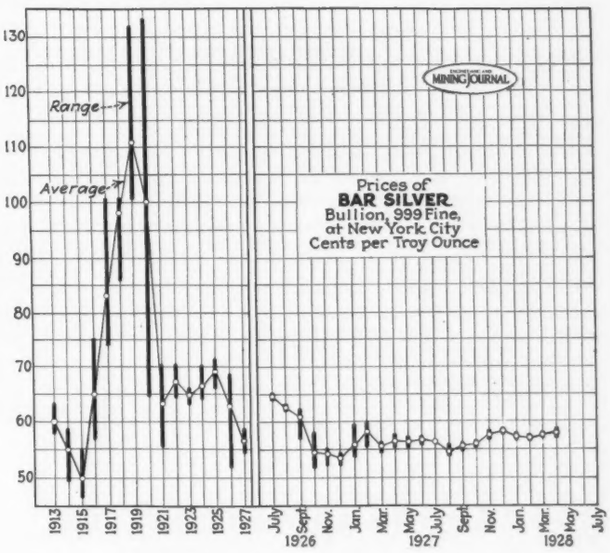
OHIO COPPER COMPANY, operating in the Bingham district, Utah, reports a net loss of $61,146 in 1927 after taxes, interest, depreciation, and depletion. This compares with a net profit of $33,017 in 1926.

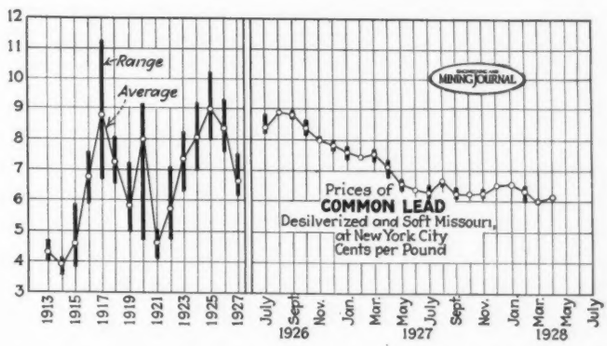
GRANBY CONSOLIDATED COPPER COMPANY re-enters the list of dividend payers with the announcement of a $1 per share disbursement on May 1, to shareholders of record April 13. This dividend is a distribution of capital, as provided for at the special meeting of stockholders held in December, 1927. Outlining of the Bonanza orebody at Anyox by diamond drilling is progressing, and the company expects to extract ore from this body in 1928. If the present price of copper is maintained, Granby expects to continue its dividend rate at $4 per share per year and to make future payments from earnings.

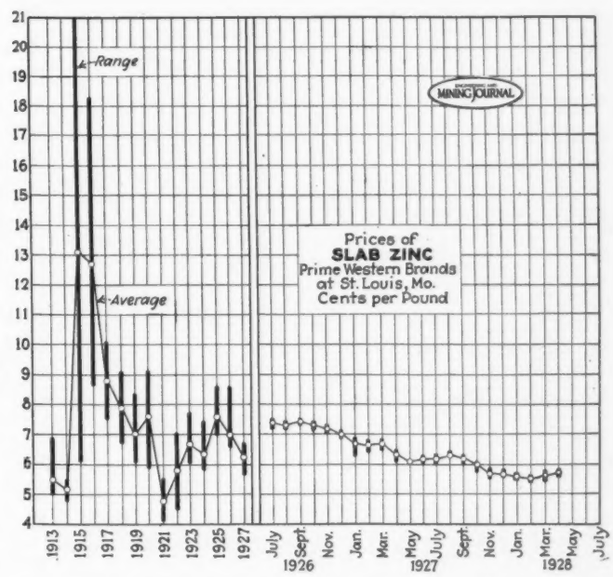
LORRAIN TROUT LAKE MINES, LTD., operating in the Cobalt district of Ontario, suffered a loss in its operation for 1927 of $32,700. Silver production for the year was 109,941 oz., against 143,399 oz. in 1926.

Metal Price Curves

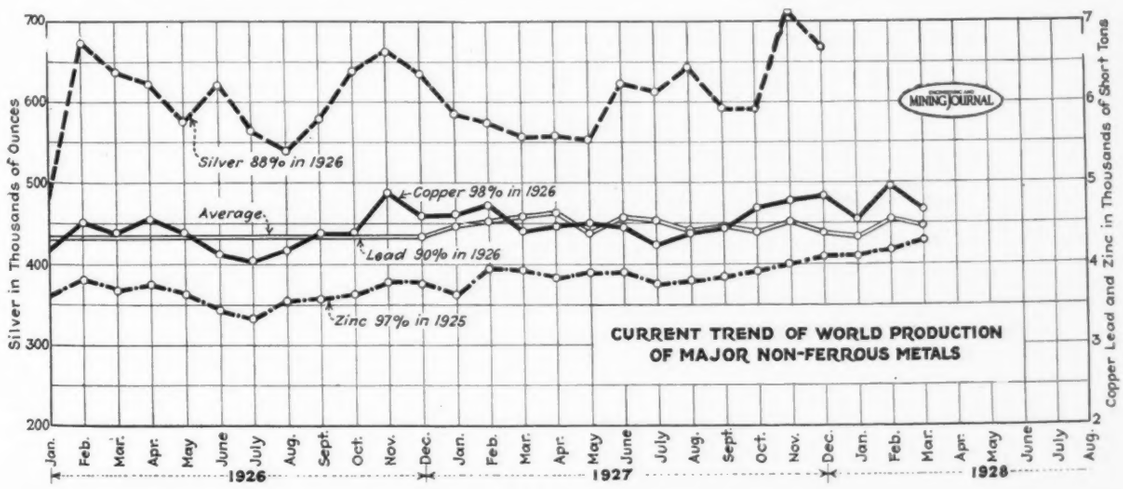








THE CURVES below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output according to the latest estimates of the American Bureau of Metal Statistics. The figures represent production from countries that produce approximately 98 per cent of the world's copper, 97 per cent of the zinc, 90 per cent of the lead, and 88 per cent of the silver. The figures for lead on the new basis are not available for the individual months of 1926, and accordingly a horizontal line showing the monthly average reduced to a daily rate is shown. Delay in receipt of statistics from Mexico accounts for the failure of the silver curve to be up to date.



Review of Current Statistics

By Homar L. Johnson
Editorial Staff

THE consistent decline of *Engineering and Mining Journal's* Weighted Index of Non-Ferrous Metal Prices that has taken place since December was arrested in April, when an advance of 0.92 units was recorded. Copper, lead, and zinc were the major factors in this reaction. Silver and tin contributed to some extent; no change was recorded in aluminum or nickel.

Respecting copper the situation is more nearly in hand than at any time since the formation of the Copper Institute. The full producer's price of 14¼c. delivered, Connecticut Valley, may be considered as virtually established. Current tonnage of metal available at prices below that level decreased appreciably during the month. The number of sellers offering metal at shaded prices also decreased as the month drew to a close. Copper statistics for April are expected to be very favorable, in view of the large domestic and foreign shipments. With stocks well in hand and probably 90 per cent of May production sold, producers feel that things are coming their way at last.

The price of lead was firm in April. Sales and deliveries were in excellent volume during the early part of the month. At least two of the large producers found it necessary to draw upon their accumulated stocks to satisfy consumers' requirements. London registered a net advance for spot metal of somewhat more than one pound sterling during April.

A new world's production record was established for zinc in March, the last month for which production statistics are available. Producers exhibited little inclination to sell at the lower levels, in spite of the unfavorable statistics, because of the high price they were forced to pay for concentrates in the Tri-State district. Consumers have bought sparingly, and only for immediate needs, but the price of zinc has advanced steadily, if not rapidly, throughout the month. It is difficult to be optimistic over the zinc situation, but it does appear that in the immediate future prices are likely to continue firm and slightly higher, as smelter operators cannot continue tc operate at a loss. The only satisfactory solution seems to be lower prices for concentrates or higher prices for slab zinc.

Among the share indices, the trend does not conform to that of the Weighted Non-Ferrous Metal Index. The mining-smelting-manufacturing group index continues to advance in record-breaking fashion, but the other two share indices progressed downward. Of the seven mining-smelting-manufacturing companies, Anaconda and New Jersey Zinc pushed upward into previously unexplored fields. Anaconda's advance was from 61⅛ to 72½ and New Jersey's was even more phenomenal—198 to 249. Speculative interests are reported to be operating on the Anaconda group, but no acceptable explanation of New Jersey Zinc's 25 per cent rise is forthcoming. International Nickel suffered a loss of slightly less than 4 points; other members of the group were virtually unchanged.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54

	1926	1927	1928
September	109.27	96.01	——
October	106.20	95.36	——
November	104.21	96.22	——
December	102.31	98.30	——
January	112.66	100.46	97.54
February	111.91	100.01	96.73
March	108.95	100.84	96.22
April	105.93	98.63	97.14

The Weighted Index of fourteen copper mining companies, records a slight recession from the March figure. This is significant so far as it indicates that many of the stocks are undergoing downward reactions after having been carried to unusually high levels by the initial surge of optimism that greeted copper shares on the stock exchanges when the producers won their first skirmish in the battle to maintain the price of copper at the 14⅛-14¼ level, late in March. Nevada Consolidated, Calumet & Arizona, United Verde Extension, Magma, and Granby Consolidated were leading factors in the decline. Chile and Inspiration advanced with the other members of the Anaconda group. Quincy, one of the smaller Lake producers, advanced from 13⅛ to 19½ during the period under review; credit for this appreciation is attributed to a recent strike of new and high-grade ore on its 87 level. New Cornelia advanced slightly, and Kennecott, Calumet & Hecla, Copper Range, Miami, and Old Dominion underwent no appreciable change.

Among the Miscellaneous Index members declines are likewise predominant. Nine of the thirteen companies experienced a depreciation in value, of which the following exerted a material influence in the reduction of the Index number: Premier Gold, Hecla, Hollinger Consolidated, Lake Shore, and Federal Mining & Smelting. Premier's decline was sufficient to offset a steady advance since the first of the year. Hollinger's decline has been persistent since December. Declines of minor significance were registered by St. Joe Lead, Tintic Standard, Cresson Consolidated, and Utah-Apex. The four advances are claimed by Cerro de Pasco, Silver King Coalition, Howe Sound, and Homestake. Silver King Coalition's position is particularly noteworthy as it is the first sign of strength shown by any of the silver-lead or silver-lead-zinc members of this group in three months. The efficient management, and operating record of this Utah producer, coupled with the higher silver content of the ore now being mined, may be the explanation for this advance, coming, as it does, in the face of the continued low prices for the metals it produces.

The Non-Metallic Index is higher, after remaining unchanged for two months. Gravel fluorspar, 85-5 grade, is $1 per ton higher in the Kentucky-Missouri fields, and Grade A calcined magnesite has been advanced $2 per ton in California. However, No. 1 pottery grade feldspar from the North Carolina district is 25c. per ton lower, the net result of the three changes being an advance in *Engineering and Mining Journal's* Non-Metallic Index, from 105.84 for March to 106.13 for April.

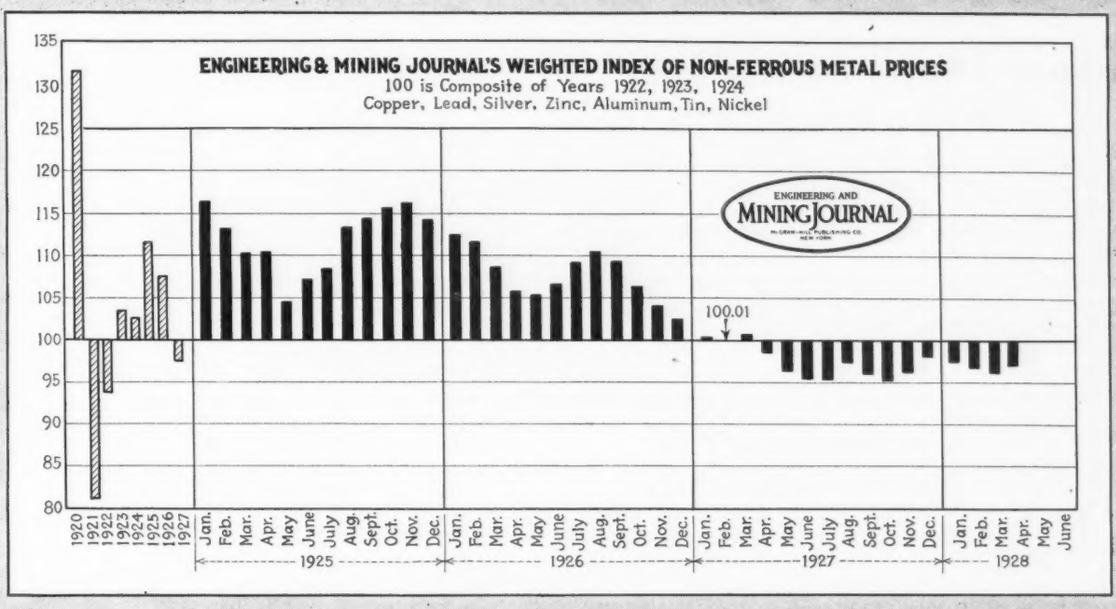
Current Statistics of Production and Stocks of Copper, Lead, and Zinc

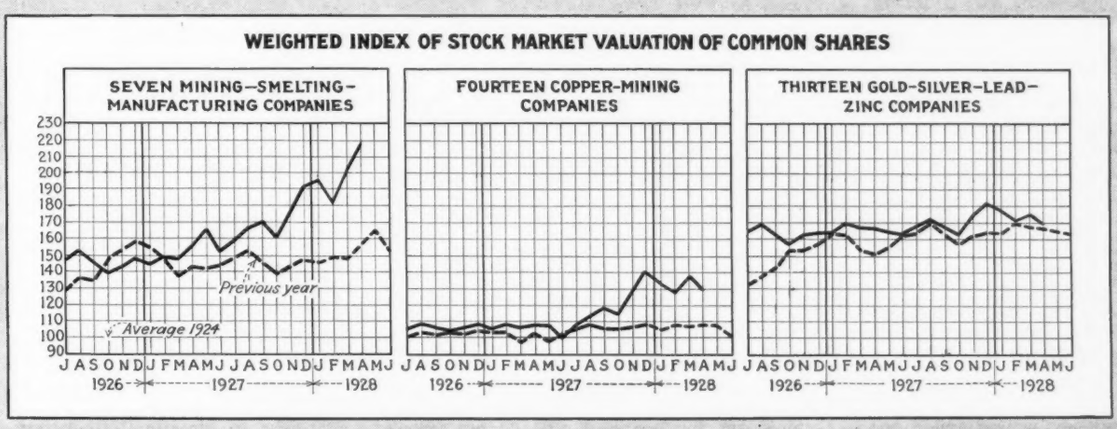
Data from American Bureau of Metal Statistics

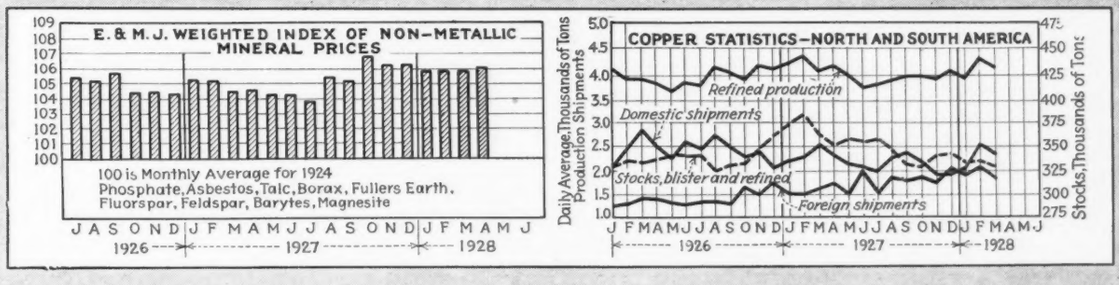
Figures Represent Short Tons

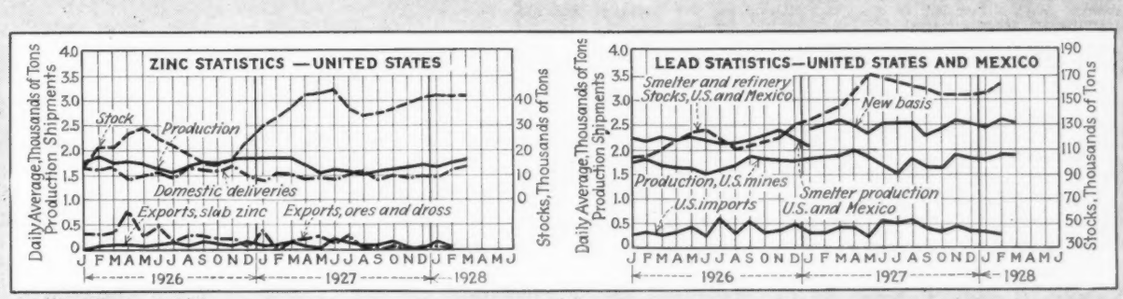
	1927		1928		
	Average	March	January	February	March
COPPER—North and South America					
Production, refined, daily average	4,045	4,096	3,959	4,305	4,160
Domestic shipments	68,737	78,948	64,824	73,789	72,642
Foreign shipments	53,489	49,767	56,721	60,603	55,970
Stocks, blister and refined	351,611	366,005	334,437	334,461	329,813
LEAD—United States and Mexico					
Production, smelter, daily average	2,513	2,623	2,479	2,630	2,532
Production, U. S. mines, daily average	1,798	1,883	1,745	1,894	1,871
Imports into U. S. A.	13,451	14,443	10,418	8,574	.....
Stocks, smelter and refinery	156,878	145,766	157,417	167,692	173,338
ZINC—United States					
Production, daily average	1,681	1,824	1,691	1,726	1,803
Domestic deliveries	45,811	48,107	45,771	46,754	51,856
Exports, slab zinc	3,468	4,189	4,649	2,125	2,558
Exports, ores and dross	4,424	2,889	2,444	890	1,898
Stocks	37,602	36,279	42,163	41,290	41,529
World Production Rate (Daily average)					
Copper	4,543	4,398	4,534	4,984	4,672
Lead	4,514	4,658	4,339	4,523	4,494
Zinc	3,910	3,983	4,084	4,181	4,298

E.&M.J. Statistics of the Mining Industries






E. & M. J. WEIGHTED INDEX OF NON-METALLIC MINERAL PRICES
100 is Monthly Average for 1924
Phosphate, Asbestos, Talc, Borax, Fullers Earth, Fluorspar, Feldspar, Barytes, Magnesite
COPPER STATISTICS—NORTH AND SOUTH AMERICA
Refined production
Domestic shipments
Stocks, blister and refined
Foreign shipments
Daily Average Thousands of Tons Production Shipments
Stocks, Thousands of Tons
1926
1927
1928



The Market Report

Copper Position Excellent—Zinc and Silver Prices Advance

New York, May 9, 1928—Copper sellers did an immense business during the week ending today, virtually all of it on the basis of 14.25c. Connecticut. Zinc, though not particularly active, has commanded better prices, and 6c. has been realized on several sales for future delivery. Lead and tin have both been quiet, and occasional shading of the prices for lead that have prevailed for some weeks is reported; tin sagged slightly, but is a little firmer today. Silver as a consequence of the disturbed conditions in the Orient has strengthened, and at 59¾c. reached a new high since February, 1927. Antimony also felt the effects of the situation in China and is quoted 1c. higher than a week ago. Quicksilver is a little lower. Platinum is unchanged.

Daily Prices of Metals

May	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
3	14.00@14.025	51.875	6.10	6.00	5.85@5.875
4	14.025@14.05	51.625	6.05@6.10	6.00	5.875@5.90
5	14.025@14.05	51.625	6.05@6.10	6.00	5.875@5.90
7	13.975@14.05	51.125	6.10	5.975@6.00	5.90@5.95
8	13.975@14.05	51.375	6.10	6.00	5.95@5.975
9	14.025@14.05	51.875	6.10	6.00	5.95@6.00
	14.025	51.583	6.092	5.998	5.917

Average prices for calendar week ending May 5, 1928, are: Copper, 14.025; Straits tin, 51.417; N. Y. lead, 6.088; St. Louis lead, 6.000; zinc, 5.863; and silver, 58.417.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted, and prices at so-called Middle West destinations, 0.325c. above.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

May	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
3	61 7/16	61 3/4	66 1/2	232 3/4	231 3/4	20 9/16	20 3/4	26 1/4	25 13/16
4	61 7/16	61 3/4	66 1/2	233 1/2	233	20 3/8	20 9/16	26 5/16	25 15/16
7	61 3/8	61 5/8	66 1/2	232 3/4	231 3/4	20 5/16	20 9/16	26 5/16	25 7/8
8	61 7/16	61 11/16	66 1/2	232	231 1/8	20 3/16	20 1/2	26 5/16	25 15/16
9	61 9/16	61 13/16	66 1/2	233	232 3/8	20 1/4	20 9/16	26 3/8	26

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

May	Sterling Exchange "Checks"	Silver		Gold London	May	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
3	4.87 1/2	58 3/4	26 3/4	84s11d	7	4.87 5/8	58 3/4	27	84s11 1/4d
4	4.87 9/16	58 1/2	26 15/16	84s11d	8	4.87 5/8	59 1/8	27 1/8	84s11 1/4d
5	4.87 5/8	58 1/4	26 3/4	.....	9	4.87 9/16	59 3/4	27 9/16	84s11 1/2d
					Avg.		58.792		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command three-eighths cent premium.

Copper Very Active at 14¼c.

Producers of copper, without exception, are unusually optimistic over the market outlook. Business has been unusually good, the tonnage equaling the total sold during the preceding four weeks. Several sales for July delivery were made at a slight concession from the 14¼c., Connecticut, price at which the bulk of the business was done. On the other hand, a good tonnage was sold in the Middle West area at 14⅜c. Just why it was necessary to cut prices in order to place July business is rather puzzling, for some sellers were able to get the full price for that position. It appears that a large number of consumers asked that their May contracts be filled during the first week of the month. This, taken in conjunction with some furnace troubles at the refineries, whereby the supply of shapes shrunk considerably, has caused a squeeze for metal for prompt delivery. Though this condition is probably only temporary, it has shown consumers that their hand-to-mouth buying had put them on rather thin ice, and this has been one reason for the active buying. June has been the month specified in most sales. Data of the Copper Institute indicate that neither domestic nor foreign consumers have yet covered their May requirements entirely, and that until this week only a start had been made on June. Doubtless a considerable decline in stocks of refined metal will be disclosed by the April statistics; and all these factors lend strength to the situation. In some quarters, an early advance in prices is forecast, but some, at least, of the producers would prefer to let matters rest as they are for the present. The c.i.f. price of Copper Exporters continues to be maintained at 14.50c., and 15,000 tons has already been sold this month.

Lead Prices Not Firm

None of the lead-selling agencies have had a very active week. Consumers seem to be well supplied and are making few inquiries; on the other hand, producers are not burdened with stocks and have not made energetic efforts to sell. In the East, the contract price of the American Smelting & Refining Company continues at 6.10c., New York, and most of the sales have been on that basis. One seller, however, perhaps a little more anxious to sell than the others, has quoted as low as 6.05c. and has marketed a few hundred tons at that level for any delivery that the consumer has required. In the Middle West, the general asking price has been 6c., St. Louis, and 6.05c., Chicago, though in that market, as in New York, no great degree of firmness is in evidence. Some lead has actually been sold at 5.975c., St. Louis, and it is probable that that price would be duplicated, or perhaps an even further concession made, on attractive business. Either desilverized or chemical lead can be obtained in the Middle West at even prices, though corroding grades com-

mand the usual premium of $2@$3.

Some producers report that almost all of the demand is for prompt shipment, but others have sold a fair tonnage for July. Battery manufacturers have been conspicuous by their absence from the market recently, their requirements evidently being fully covered by contract orders.

Zinc Touches 6c.

Cables from Brussels state that an agreement to continue to the end of this year has been reached by the principal European zinc interests looking to the control of production and prices abroad. Anticipation of this development probably has been a factor in recent strength in the domestic market. Moreover, production in Joplin has been considerably under the tonnage bought by smelters. Although galvanizers as usual complain that business is not good with them, they continue to buy zinc from week to week. Prompt metal may be had at slightly lower prices than that for June-July delivery. High-Grade metal is quoted nominally at 7½c. for small spot shipments.

Tin Dull but Steady

Demand for tin continues almost nonexistent, but no concessions in price are being made to attract buyers, the market for the week having held between 51 and 52c. Consumers evidently expect lower prices, but may have to buy before any further marked reductions are made. Forward shipment is obtainable about ¼c. under prompt Straits. A little 99 per cent grade tin has appeared on the market and has sold at from ½ to ¾c. under the prices realized on Straits.

Silver Reaches New High at 59¾c.

Unsettled conditions in China, resulting in a heavy demand for silver from that source against sales of Japanese yen, and good buying from India, have been the cause of the sharp rise in the market in the last week. The quotation today of 59¾c. is the highest since Feb. 3d, 1927. The closing tendency is quiet and uncertain.

Mexican Dollars (Old Mexican pesos): May 3d, 44⅜c.; 4th, 44⅞c.; 5th, 44⅝c.; 7th, 45⅛c.; 8th, 45½c.; 9th, 46⅛c.

Foreign Exchanges Weaken

The tendency in the foreign exchange market has been slightly downward recently, especially the Japanese yen. Closing cable quotations on Tuesday, May 8, were: Francs, 3.935c.; lire, 5.27c.; and marks, 23.925c. Canadian dollars, 3/32 of 1 per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.50c.; 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid. New York: Chinese brands, for all positions, 11¼c. Market stronger.

Correction: Chinese brands, for all positions, were erroneously quoted at 9½c. per lb. in the issue of May 5. The quotation should have been 10⅜c. per lb.

Cookson's "C" grade, spot, 15⅜c. Needle antimony nominally 7½c. for lump and 10c. for powdered. White oxide, Chinese, 99 per cent Sb_2O_3, 11¼c.

BISMUTH—Per lb., New York, in ton lots, $2.10. Smaller lots, $2.25 and up.

IRIDIUM — Per oz., $275@$300 for 98@99 per cent sponge and powder. Market dull, prices largely nominal.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $46@$49. Small lots bring up to $55. Absolutely no activity in market.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $78. Dealers and refiners quote the trade for refined metal, per oz., cash, for wholesale lots, $73.50@$74 bid, $75.50@$76.50 asked. Market very quiet.

QUICKSILVER — Per 76-lb. flask, $122@$123, depending on quantity. San Francisco wires $124.

Prices of Cadmium, Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of May 5.

Metallic Ores

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn: 35@38c. Caucasian, washed, 53@55 per cent, 38@40c. Chemical grades unchanged from quotations in the May 5 issue.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $10.50@$10.60. Western scheelite, $10.60@$10.75.

Chrome, Iron, Tantalum, and Titanium ores are unchanged from quotations in the May 5 issue.

Zinc Ore Advanced $1 Per Ton

Joplin, Mo., May 5, 1928

Blende

	Per Ton
High	$40.25
Premium, basis 60 per cent zinc	$39.00@41.00
Prime Western, 60 per cent zinc	39.00
Fines and slimes, 60 per cent zinc	35.00@38.00
Average settling price, all zinc	37.91

Galena

High	$78.80
Basis 80 per cent lead	77.50
Average settling price, all lead	76.54

Shipments this week: Blende 10,714 tons; lead, 1,659 tons. Value all ores the week, $533,190.

Buyers are hoping to get approximately 15,000 tons of ore this week, about 5,000 tons in excess of the output. The shipment was only 200 tons more than the output, an insufficient tonnage to supply the need of the smelters. Following a slight flurry in the lead-ore

Platteville, Wis., May 5, 1928.

Zinc Blende	Per Ton
Blende, basis 60 per cent	$40.75
Lead Ore	
Lead, basis 80 per cent lead	$78.50

Shipments for the week: Blende, 759 tons; lead, 80 tons. Shipments for the year: Blende, 13,207 tons; lead, 800 tons. Shipments for the week to separating plants, 1,286 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the May 5 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic)—Per lb., 4c. Market quiet.

Calcium Molybdate, Copper Sulphate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the May 5 issue.

Ferro-Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $100 quoted for second quarter, 1928. Spiegeleisen, 19@21 per cent, $32 f.o.b. furnace.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent, 92@95c. f.o.b. works.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, and Ferrovanadium are unchanged from prices in the May 5 issue.

Metal Products

Rolled Copper, Lead Sheets, Nickel Silver, and Yellow (Muntz) Metal, and Zinc Sheets are unchanged from prices in the May 5 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of May 5.

Iron, Steel, and Coke

Iron—Per gross ton, Valley furnaces, Bessemer, $17.50; basic, $16@$16.50; No. 2 foundry, $17.25.

Steel—Base prices per gross ton. Pittsburgh, billets and slabs, $33; plates, structural shapes, and soft steel bars, per pound, 1.85@1.90c.

Coke—Per gross ton. Connellsville furnace, contract, $2.75@$3; spot, $2.50@$2.75. Connellsville foundry, contract, $3.75@$4.25; spot, $3.60@$4.25. By-product coke, Ohio and Kentucky $7; Buffalo and Detroit, $8.50@$9. market last week, by one buyer seeking an increased tonnage for this week's shipment, the market has settled back, with slackened demand and little inclination by producers to sell.

Mining Stocks—Week Ended May 5, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	72½	69½	71¾	Ap.14, My.21 Q	0.75
Ariz. Com'l	Boston	5	4½	4½	Ja. 19, Ja. 31 SA	0.25
Cal. & Ariz	New York	103¾	99½	103¾	Ma. 3, Ma. 19 Q	1.50
Calumet & Hecla	Boston	23½	21½	23¾	Fe. 28, Ma. 15 Q	0.50
Cerro de Pasco	New York	69½	67½	68½	Ap.12, My.1 Q	1.00
Chile Copper	New York	43⅝	42½	43½	Jn.6, Jn.30 Q	0.62½
Con. Coppermines	N. Y. Curb	13½	11	13		
Copper Range	Boston	19½	17½	18⅝	Ma. 24, Ap. 20 A	1.00
Crystal Copper	Boston Curb	*96	*85	*95		
East Butte	Boston	2½	2	2½	Dec., 1919	0.50
Granby Consol	New York	49¾	47¾	48	Ap.13, My.1 Q	1.00
Greene Cananea	New York	124	117	120	Nov., 1920	0.50
Howe Sound	New York	57½	52⅝	56	Ma.31, Ap.16, Q	1.00
Inspiration Consol	New York	23	21⅜	21⅜	Apr. 1927 Q	0.25
Isle Royale	Boston	15⅜	15	15½	Fe.28, Ma.15 SA	0.50
Kennecott	New York	89⅜	85⅞	88	Ma. 2, Ap. 2 Q	1.25
Magma Copper	New York	50⅜	48½	50	Ma.31, Ap.16 Q	0.75
Mason Valley	N. Y. Curb	1½	1½	1½		
Miami Copper	New York	19½	18⅜	19	My.1, My.15, Q	0.37½
Mohawk	Boston	59½	56	58	Ap. 30, Jn. 1 Q	1.00
Montana-Idaho	Spokane	*33	*33	*33		
Mother Lode Coal	New York	3½	3½	3½	De.16, De.31 SA	0.25
Nevada Consol	New York	23	20⅞	23	Ma.16, Ma.31 Q	0.375
New Cornelia	Boston	28½	28	28½	My. 4, My. 21 Q	0.50
Noranda	N. Y. Curb	21	18½	20¾		
North Butte	Boston	2⅜	2⅛	2⅜	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*86	*81	*81	Sept., 1926	0.03
Old Dominion	Boston	11½	10½	10½	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	127½	124½	124¾	Ma.20, Ap.2 Q	1.50
Quincy	Boston	26	21	24	March, 1920	1.00
St. Mary's Min. Ld	Boston	28	26½	27½	Ap.1928 A	2.00
Seneca Copper	New York	2¾	2½	2¾		
Shattuck-Denn	N. Y. Curb	24¾	21	21½		
Tenn. C. & C	New York	14½	13	14½	Fe.29, Ma.15,Q	0.12½
United Verde Ex	N. Y. Curb	20	19½	19⅝	Ap.6, My.1, Q	0.50
Utah Copper	New York	149⅜	149⅜	149⅜	Ma.16, Ma.31 Q	1.50
Utah Metal & T	Boston	1¼	1⅛	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	*84	*80	*80		
NICKEL-COPPER						
Internat. Nickel	New York	92	88½	91⅜	Ma.15, Ma.31Q	0.50
Internat. Nickel pfd	New York	...	..	115	Ap.12, My.1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*7½	*7,	*7½	June, 1927	0.005
National Lead	New York	133¾	129¾	130	Ma.16, Ma.31Q	1.25
National Lead, pfd. A	New York	147	147	147	Ju.1, Ju.15 Q	1.75
National Lead, pfd. B	New York	120½	120	120½	Ap. 23, My. 1 Q	1.50
St. Joseph Lead	New York	41¾	39½	40¼	Jn.9, Jn.20, QX	0.75
ZINC						
Am. Z. L. & S	New York	26½	24	25½	May, 1917	1.00
Am. Z. L. & S. pfd	New York	89¾	86½	86½	Nov., 1920	1.50
Butte C. & Z	New York	6½	5⅜	5⅜	De., 1926	0.50
Butte & Superior	New York	10½	10	10	Ma.14, Ma.31 Q	0.50
Callahan Zn-Ld	New York	5⅜	3⅜	3⅜	De., 1920	0.50
Consol.Lead&Zinc 'A'	St. Louis	12¾	12	12¼	Ap., 1927	0.25
Eagle-Picher	Cincinnati	17	16	16⅜	No.15, De.1 Q	0.40
Eagle-Picher pfd	Cincinnati	104	104	104	Ma. 31, Ap. 16 Q	1.50
New Jersey Zn	N. Y. Curb	260	236	236	Ap. 20, My. 10 Q	2.00
Treadwell-Yukon	Toronto	21.00	20.00	21.00		
United Zinc	N. Y. Curb	*98	*60	*75		
Yellow Pine	Los Angeles	...	...	*32	Dec., 1925 Q	0.04
GOLD						
Alaska Juneau	New York	4⅛	3⅞	3⅞		
Argonaut	Toronto	*8	*7	*8		
Barry-Hollinger	Toronto	1.02	*81	*85		
Central Manitoba	Toronto	1.32	1.27	1.28		
Con.W.Dome L. new.	Toronto	*11	*10	*10½		
Cresson Consol. G	N. Y. Curb	1 11/16	1 5/16	1⅜	Ma.31, Ap.10 Q	0.10
Dome Mines	New York	10⅛	9⅜	10½	Ma.31, Ap.20 Q	0.25
Golden Cycle	Colo.Springs	†1.78	†1.75	...	Fe.29, Ma.10 Q	0.04
Gold Hill	Toronto	*19	*17	*17½		
Hollinger Consol	Toronto	16	15	15	My.2, My 19	0.10
Homestake Mining	New York	73	71	71	My.19, My.25 M	0.50
Kirkland Lake	Toronto	1.85	1.75	1.84		
Lake Shore	Toronto	23.95	23.15	23.25	Ma.1, Ma.15QX	0.20
McIntyre Porcupine	New York	25½	25⅜	25½	May1, Ju.1 Q	0.25
Portland	Colo.Springs	†20	†17½	...	Ap., 1927	0.02
Rand Mines	New York	44	44	44	Fe.21-28 Am.Sh.	1.52
Sylvanite	Toronto	3.23	3.18	3.23		
Teck-Hughes	Toronto	9.50	9.25	9.45	Ja. 17, Fe. 1 X	0.15
Tom Reed	Los Angeles	*40	*32	*32	Dec., 1926	0.02
Tough-Oakes	Toronto	*40	*35	*37		
Vipond Cons	Toronto	*62	*55	*61	April, 1927	0.03
Wright-Hargreaves	Toronto	4.60	4.35	4.40	Ap.13, My.1 Q	0.05
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	26½	25	25		
Con. Cortez	N. Y. Curb	*31	*30	*31		
Dolores Esperanza	N. Y. Curb	1⅝	1½	1½	July, 1923	0.05
N.Y. Hond's Rosario	N. Y. Curb	17½	16½	16½	Ap.18, Ap.28 Q	0.50
Premier Gold	N. Y. Curb	2½	2½	2 7/8	Ma.15, Ap.4	0.08
Tonopah Belmont	N. Y. Curb	1 1/16	1	1 1/16	Oc., 1925	0.05
Tonopah Extension	N. Y. Curb	*12	*12	*12	Ap., 1925	0.05
Tonopah Mining	N. Y. Curb	4	4	4	Mar.31, Ap.21 SA	0.07½
West End Consol	N. Y. Curb	...	...	*4	Mar., 1923	0.05
Yukon Gold	Boston Curb	*73	*62	*62	June, 1918	0.02
SILVER						
Beaver Consol	Toronto	1.40	1.30	1.36	May, 1920	0.03
Castle-Trethewey	Toronto	*60	*56	*59		
Coniagas	Toronto	5.50	5.10	5.50	May, 1924	0.12½
Keeley	Toronto	*60	*60	*60	Ma.1, Ma.15 SA	0.04
Lorrain Trout Lake	Toronto	...	...	*30	July, 1925	0.05
Mining Corp. Can	Toronto	3.65	3.40	3.41	Ja.10, Ja.25 SA	0.125
Nipissing	N. Y. Curb	4⅜	4⅛	4¼	Ma.31, Ap.20Q	0.07½

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	5½	4½	5	Ap., 1927	0.12½
Bingham Mines	Boston	49	49	49	Ma.22, Ap.5 Q	1.00
Bunker Hill & Sullivan	N. Y. Curb	137½	137	137	Ap.30, My.4 MX	0.75
Cardiff M. & M	Salt Lake	*75	*71	*73	Feb. 5, 1927	0.10
Chief Consol	Salt Lake	4.35	4.20	4.35	Ja. 10, Fe. 1 Q	0.10
Consti'nMng.&Mill'g.	Spokane	*15	*10	*12		
Erupcion	Boston Curb	...	...	*30	Dec. 13, Jan. 3,	0.07½
Eureka Lily	Salt Lake	2.15	1.90	2.12½		
Federal M. & S	New York	120	120	120	Je., 1927	10.00
Federal M. & S. pfd	New York	...	...	95	Fe.24, Ma.15 Q	1.75
Hecla Mining	N. Y. Curb	15⅞	13½	15⅞	My.15, Jn.15 Q	0.15
Highland-Surprise	Spokane	*12½	*10	*12½		
Iron King Mining	Salt Lake	*54	*51	*53		
Keystone Mining	Salt Lake	†1.32½	†1*25	...	Fe., 1926	0.07½
Lucky Jim	Spokane	*38	*36	*36		
Lucky Tiger-Com	Kansas City	†7.75	†7.50	...	Ap.10, Ap.20MX	0.07
Mammoth Mining	Salt Lake	†2.00	†1.50	...	De., 1926	0. 25
North Lily	Salt Lake	7.30	7.20	7.25		
Park Utah	New York	13⅞	10⅜	12⅜	Ma.15, Ap.15 Q	0.20
Plutus Mining	Salt Lake	2.00	2.00	2.00	Ap.10, Ap. 16 Q	0.10
Silver King Coal	Salt Lake	11.75	11.12½	11.75	Ma.20, Ap.2 Q	0.25
Silversmith	Spokane	*18½	*17	*18½	Oct., 1926 Q	0.02
Strattons Mines	Spokane	*45	*41	*44		
Sunshine M. Co	Spokane	1.45	1.40	1.45	Fe.10, Fe.20	0.10
Tamarack-Custer	Spokane	*90	*84½	*84½	Sept., 1924	0.25
Tintic Standard	Salt Lake	14 00	13.12½	14.00	Ma.21, Ma.29Q	0.30
Utah-Apex	Boston	4⅜	4⅛	4⅜	Oct., 1926	0.25
IRON						
Bethlehem Steel	New York	64	60½	63⅜	Jy., 1924	1.25
Cleveland-Cliffs Iron	Cleveland	115	115	115	Ap.13, Ap. 25. Q	1.00
Colorado Fuel & Iron	New York	77⅜	72½	76½	May, 1921	0.75
Gt. North'n Iron Ore	New York	23½	22⅛	23⅛	Ap. 9, Ap. 30 K	0.75
Inland Steel	New York	56½	55	55⅜	My. 15, Jn.1 Q	0.62½
Republic I. & S	New York	60⅜	59	60	My.15, Jn.1 Q	1.00
Republic I. & S. pfd	New York	108	107½	107½	Jn. 15, Jy. 2 Q	1.75
Sloss-Sheffield S. & I	New York	117½	116	117½	Ma.10, Ma.20 Q	1.50
Sloss-Snef. S.&I. pfd	New York	...	...	122½	Ma. 20, Ap. 2 Q	1.75
U. S. Steel	New York	148½	144⅜	148	My.31, Jn.29 Q	1.75
U. S. Steel, pfd	New York	145⅛	144⅜	145	Ap. 30, My. 29 Q	1.75
Virginia I. C. & C	New York	...	...	31½	Jan., 1924	1.50
Virginia I.C.&C. pfd	New York	58	56	58	De. 16, Ja. 3 SA	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	27	26½	27	Jy., 1927	1.45
So. Am. G. & P. New	N. Y. Curb	3½	3½	3½		
Alum. Co. of Amer	N. Y. Curb	150½	145	148		
Alum. Co. of Amer. pf.	N. Y. Curb	109¾	109½	109½	Ma. 15, Ap. 1 Q	1.50
Vanadium Corp	New York	84⅜	82½	83½	My. 1, My. 15 Q	0.75
Patino M. & E	New York	42	36½	38⅜	April, 1928	4s.
ASBESTOS						
Asbestos Corp	Montreal	39½	33¾	38	Jan., 1926	1.50
Asbestos Corp. pfd	Montreal	100	93½	94½	Ma. 31, Ap. 16 Q	1.75
SULPHUR						
Freeport Texas	New York	84	77½	81⅜	Ap.14, Ma.1 QX	1.75
Texas Gulf	New York	75¾	73¼	73¼	Ma. 1, Ma. 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	49½	44⅜	48½	My.15, Jn.1	0.75
Amer. Metal, pfd. 6%	New York	116½	114⅜	116	My.15, Jn.1	1.50
Amer. Met. pfd. 7%	New York	126	126	126	My.15, Jn.1	1.75
Amer. Sm. & Ref	New York	192½	185⅜	192	Ap.13, My.1 Q	2.00
Amer. Sm. & Ref. pfd	New York	141½	140	140	My. 4, Jn. 1 Q	1.75
Consol. M. & S	Montreal	282½	272	278	De. 31, Ja. 16 X	6.25
Newmont Mining	N. Y. Curb	175⅜	171	175	Ma.31, Ap.16 Q	1.00
U. S. Sm. R. & M	New York	46	43	45⅞	Ap.5, Ap.14 Q	0.87½
U.S. Sm. R.&M. pfd	New York	55½	54⅛	55½	Ap.5, Ap.14 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. A, Annual. SA, Semi-annually. M, Monthly. K, irregular. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED APRIL 24, 1928

Name	High	Low	Last	Date	Last Div. Amount
Alaska Mexican	40/6	39/6	40/—		
Alaska Treadwell	136/—	135/—	135/—	Nov., 1926	4 (§)
Aramayo Mines (25 frs.)	68/9	65/—	68/—	May, 1928	5 p.c. (†)
Burma Corpn. (10 rupees)	13/6	12/7½	13/4½	Jan., 1928	6 annas*
Bwana M'Kubwa (5s)	5/1½	4/7½	4/10½		
Camp Bird (2s)	5/3	4/6	5/1½	April, 1928	16⅔ p.c.
El Oro (£1)	4/6	4/3	4/6	Nov., 1924	2½ p.c.*
Frontino & Bolivia (£1)	14/6	14/—	14/6	Jan., 1928	5 p.c.
Mexican Corpn. (£1)	10/—	7/6	9/9		
Mexico Mines of El Oro (£1)	30/—	25/—	26/3	Dec., 1926	3⅓ p.c.*
Mond Nickel	162/6	150	161/3	Feb., 1928	7½ p.c.
N'Changa Copper Mining	12/6	11/—	11/9		
Oroville Dredging (£1)	4/3	3/7½	4/3	Dec., 1923	3⅓ p.c.
Rhodesian Congo Border (£1)	24/4½	21/—	22/6		
St. John del Rey (£1)	13/7½	12/10½	13/6	May, 1927	3⅓ p.c.
San Francisco Mines (10s)	28 —	27/4½	28/—	Jan., 1928	25s.
Santa Gertrudis (£1)	16/10½	14/9	16/10½	Jan., 1928	7½ p.c.
Selukwe (2s. 6d.)	12/4½	10/—	11/10½	April, 1917	6¼ p.c.
S. Amer. Copper (2s.)	2/7½	2/1½	2/6	Nov., 1917	75 p.c.
Tanganyika (£1)	65/—	60/7½	61/10½	Aug., 1927	7½ p.c.
Union Miniere de Haut-Katanga (Brussels)	8,225	7,862.50	7,862.50	July, 1927	182.60 (‡)

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation. §U. S. Dollars.